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THE

TEA QUARTERLY

THE JOURNAL

OF THE

TEA RESEARCH INSTITUTE

OF CEYLON

THE TEA RESEARCH INSTITUTE,
St. Coombs, Talawakelle,
Ceylon.

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Publications.—The *Tea Quarterly* and *Bulletin* published by the Tea Research Institute will be sent free of charge, to Superintendents of Ceylon tea estates, over 10 acres in extent, and to estate Agencies dealing with Ceylon tea, if they register their names with the Director, Tea Research Institute of Ceylon, St. Coombs, Talawakelle.

Other persons can obtain the publications of the Institute on application to the Director, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4*s*. In the case of Indian cheques four annas should be added to cover commission.

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THE TEA QUARTERLY

VOLUME XXIX. JUNE, 1958. PART II

EDITORIAL COMMENT

In the present issue of the *Tea Quarterly* a practice which was adopted for a number of years by a previous Editor has been revived in the hope that it will stimulate the interest of readers in certain of its features to which their attention is drawn. This will also enable the Editor to communicate to tea planting interests in the Island any matters of importance connected with the Institute's current activities.

Vegetative Propagation of Tea

The subject of the vegetative propagation of tea has aroused considerable interest among tea planters in the Island consequent on the very encouraging results which have obtained from small-scale trials on this method. During the past two years the Tea Research Institute has intensified its investigational work on vegetative propagation and a good deal of valuable information has been obtained thereby.

Government shortly proposes to introduce a rehabilitation and replanting scheme for the replacement of uneconomic tea with high-yielding, good quality clones. Only vegetatively-propagated material is to be permitted under the scheme. It is, therefore, essential that all the information available on this subject should be placed at the disposal of members of the planting community who wish to take advantage of the scheme to improve their properties. The article by Dr. Visser and Mr. Kehl has, therefore, been written in terms which will be readily understood by any person connected with tea planting. The technical aspects of these studies will be detailed in a bulletin which the Institute proposes to publish later. Those interested can make reference to this publication when it is issued. It is hoped, however, that the present article will prove of interest and practical value to all concerned with the vegetative propagation of tea.

A symposium on the subject of 'Tea Rehabilitation and Replanting' is to be held in Colombo on November 28th at which representatives of all tea planting, research, agency and trade interests will be invited to collaborate with the Institute in pooling our information on this important new development and arriving at agreed conclusions in regard to the measures which should be adopted to ensure that the scheme meets with the greatest possible degree of success.

Quality of Tea and its Improvement

With the considerable increase in production of tea in the Island which now approaches the figure of 400 million pounds, the question of the quality of local tea has assumed great importance. The article on the improvement of quality by Mr. Keegel together with that on the chemistry of tea manufacture by Mr. Ramaswamy should give our readers valuable information and ideas on how quality in tea can be improved or, at least, maintained.

The article by Dr. E. A. H. Roberts on the estimation of some important constituents of tea which has been reproduced with the kind permission of the Editor of "Two and a Bud," the news-letter of the Indian Tea Association, Scientific Department, Tocklai, gives an account of preliminary developments in the assessment of certain characteristics of tea by chemical methods. Whether these estimations will prove of practical value particularly in respect of local teas has yet to be determined, but these investigations do indicate that with the advancement of our knowledge of the chemistry of tea it may be possible to study the effects of various factors such as temperature and time of firing, storage, quality of water used in brewing teas, etc., on liquor characters and, perhaps, to correlate assessments by tea tasters with chemical evaluations.

Investigations on the Shot-hole Borer of Tea

The series of articles by Dr. Judenko, Special Entomologist, Shot-Hole Borer Research, on his studies of the biology of the shot-hole borer (*Xyleborus fornicatus* Eich.), two of which are included in this issue, have led to the conduct of preliminary field trials on the chemical control of the pest. Before any recommendations can be made, however, all aspects of the subject will have to be investigated on lines proposed by Dr. Judenko. Only then would we be in a position to recommend with confidence the use of any chemical for the control of the borer. In the meantime it is suggested that any trials conducted on estates with chemicals against the pest should be carried out under the supervision of an Entomologist, and it is satisfactory to record that planting opinion generally is in agreement with this view.

A detailed account of the results of experiments carried out by the Special Entomologist will be published in a series of technical communications to be issued in due course.

Mites

Investigations on the control of mites with acaricides and by agronomic methods have been carried a step further, and the contributions by Messrs. Ranaweera and Easteal merit the study and consideration of the management of those estates on which scarlet mite is a troublesome pest.

Magnesium and Tea

The note by Mr. D. Roe on his experience with the spraying of some chlorotic tea bushes with magnesium salts serves to initiate a sort of planters' forum for the recording of their practical observations on new aspects of scientific tea cultivation. It is hoped others will follow suit.

SELECTION AND VEGETATIVE PROPAGATION OF TEA*

T. VISSER AND F. H. KEHL

1. Introduction

Tea raised from seed, in common with seedling trees of most crops shows considerable variation in type and yielding capacity. An illustration of the variability in yield was shown in a yield survey of individual bushes of two uniform areas consisting of 1000 and 1500 bushes respectively. The findings of this survey were that the majority of our tea bushes are low yielders and that about 1/3rd yields most of the total crop. Whilst some of this variability in yield is probably due to environmental causes, there is a large proportion of bushes of which the differences in yield must be attributed to inherent factors. Besides differences in cropping capacity there are significant variations in the quality of tea. Resistance to diseases and pests too vary markedly from bush to bush.

In many perennial crops of economic significance rapid progress has been made through the selection of outstanding mother bushes and by the multiplication of these by suitable vegetative methods to ensure the maintenance of their desirable characteristics. In planting tea it would naturally be a sound policy to use high yielding plants that produce good quality tea and possess other desirable characteristics. This can be achieved by propagating tea by cuttings, which is an easy process, cheap and capable of being done by any nurseryman with some experience.

2. Field selection

2.1 Yield

The first criterion to adopt in selecting mother bushes should be yield as it is one of the most important factors. The initial selection can be made by pluckers or pruners. The bushes which are labelled are then carefully examined by the Superintendent, who rejects any whose type renders them plainly unsuitable. He should pick out easy plucking types that branch freely, having a good spread with a dense plucking table and reject those with the following undesirable characters :

(1) an open plucking table, (2) carrying few plucking points, (3) an upright habit or poor spread, (4) having few maintenance leaves, (5) a free flowering habit, (6) a tendency to produce banji frequently, (7) very short internodes, and (8) a slow recovery from pruning.

The final selection can be done solely at the Superintendent's judgment by picking out by eye alone bushes likely to be heavy yielders. However, as appearances are apt to be deceptive, a more accurate selection is obtained by yield assessments—that is to say, the yields of all individual bushes retained (and labelled) must be recorded by weighing the flush. Yield determinations must be preferably carried out in the second year after pruning. The best method is to record the yield of 8 consecutive plucks 4 times in succession. On each occasion a number of the lowest yielders are discarded according to the following scheme :—

*Published as T. R. I. Pamphlet No. 3

(a) First 8 plucks: per 100 bushes chosen, reject the 50 lowest yielders
(b) Second 8 plucks : per 50 bushes left from (a) reject the 25 lowest yielders
(c) Third 8 plucks: per 25 bushes left from (b) reject the 8 lowest yielders
(d) Fourth 8 plucks : per 17 bushes left from (c) reject the 6 lowest yielders, leaving the 11 highest yielders of each of 100 bushes initially selected by visual observation.

It is important that a preliminary test for *quality* is carried out on the bushes thus selected. For this purpose an ordinary small-sized household mincing machine with all its parts chromium plated is suitable for rolling the leaf of a single bush. Any non-fermenters or those with taint should be rejected.

2.2 Resistance

Where *blister blight* is prevalent, it will be necessary to look for bushes that are resistant. Bushes which continue to yield plenty of flush with little or no infection during a severe attack of blister should be selected. Accordingly, such selection should be carried out during a blister blight period and preferably from young fields, as these are more liable to damage. It should be noted that the selection of blister resistant clones may now be rather difficult as a result of the widespread adoption of successful crop protection measures.

On estates where *meadow* and *root-knot eelworm*, particularly the former, are a problem, bushes should be chosen which continue to grow vigorously in heavily infested areas.

Also bushes resistant to *mites*, *shot-hole borer*, *scales*, etc. merit consideration from the selection standpoint.

Drought resistant types should be selected in areas where frequent droughts occur, the selection being made during a drought.

As each estate will have its own problems, it is advisable that every estate not only relies on clones selected elsewhere, but also carries out the selection of its own mother bushes. It is known that good bushes do exist on all estates which, if propagated, will do as well or possibly better than imported clones.

3. Subsequent selection

3.1 Treatment of selected bushes

The bushes which have been screened in the field for yield, quality, resistance, etc., are subsequently vegetatively-propagated for purposes of multiplication and final selection. Their rooting ability will be found to differ to a greater or lesser extent. Mother bushes the cuttings of which fail to root or which give a low rooting percentage under optimal nursery conditions should be discarded, irrespective of their other characteristics.

The remaining bushes must be labelled and a rough plan made showing the position of the selected bushes. Cuttings can be taken for propagation from a bush at any stage of growth. However, it is advised that a light clean prune be given to a bush at the end of its cycle and it be allowed to grow until the base of the new shoots turn woody. At low elevations this would take between 2 and 4 months and, at higher elevations, between 4 and 6 months. Bushes selected at the beginning of the pruning cycle need not be pruned again, but can be allowed to grow unplucked until shoots can be obtained for the taking of cuttings.

The breaking of the tips of the shoots about 2 to 3 weeks before the cuttings are to be taken induces axillary bud development which has been found to be an advantage.

The selected bushes which are allowed to grow should be examined again for mites and scales as the presence of these can result in poor rooting and growth. It is a sound policy to eliminate such pests before one starts to propagate rather than adopt control measures in the nursery or at a later stage.

3.2 Test and multiplication plots

Although the laying out of test plots will not be necessary on all estates, their establishment may be very useful. The procedure followed at the Institute has been to plant 25 to 50 bushes of each selected clone in rows up and down the hill. The bushes in such plots are lightly forked and manured 3 to 4 times a year during suitable weather conditions, as follows :—

Years from planting	*Minimum rate per application*
Up to 1 year	½ to ¾ oz. Sterameal A
1 to 2 years	½ oz. T. 175 mixture
2 to 3 years	¾ oz. T. 175 mixture
3 to 4 years	1—2 oz. T. 175 mixture

In case the planter wants to rely on clones selected on his own estate for planting or replanting, it is advisable to have a larger number of bushes per clone in the test plot (*e.g.* in treble rows) than mentioned above. This has the advantage that by the time the plot is in plucking and the final selection made, the clones selected can be used as "multiplication bushes" thereafter. They will then be present in sufficient numbers to cover the needs of an envisaged planting programme. The number of bushes to be planted per clone depends on the acreage which one wants to plant yearly. An estimate can be made on the basis that a mature bush (4 to 5 years or older) will yield between 500 and 700 cuttings per year.

Although the initial outlay of larger test cum multiplication plots will be more expensive, the involved expenditure is justified. It means that not a further 3 to 5 years are lost which would otherwise be needed for multiplying again those clones finally selected. The area containing the rejected clones is likely to produce a much higher yield than seedling tea.

The bushes used for the production of cuttings should be manured liberally and attention must be paid to keep them free from diseases and pests. Manuring can be done according to the above table ; in the 5th and subsequent years the application rate can be stepped up to 2 to 3 oz. T. 175 applied every 3 months. It is advisable to give the bushes from which the cuttings are taken a light prune every 15 to 20 months, so that vigorous shoots may be obtained.

The establishment of clonal units as described above is very necessary, not only to provide enough planting material eventually, but also to provide more reliable data than are available on resistance to diseases and pests, growth habit, yield and quality of each clone.

The test of the *quality* of a clone is a matter that deserves more attention than it has received so far and should not be overlooked. The method to be adopted and the equipment required should present no difficulties. Details have been published in the *Tea Quarterly*, Vol. 24/4, 1953 : 82-89. It should be emphasized that since the characteristics of a tea are influenced to a marked extent by seasonal changes and the standard of plucking, the greatest care should be taken in assessing the potential qualities of a clone. The method of manufacture should also be taken into account.

An important aspect in clonal replanting is that a number of good clones should be planted out on an estate, and on no account should planting be restricted to one " ideal " clone even if such a one did exist. The large scale planting of only one clone is attendant with the danger that some unknown disease or pest may favour that particular clone and destroy the entire plantation. Accordingly, the

cultivation of a variety of clones is advocated and these are best planted out in separate blocks of at least ½ to 1 acre, or larger depending on the acreage to be replanted.

4. Propagation

4.1 Choice and treatment of cuttings

It is advisable not to start propagation during the latter part of the dry season or during a drought, as cuttings taken during these periods are often too mature, resulting in impeded rooting and growth. Otherwise, cuttings can be taken from any primary shoot that has reached sufficient maturity for that purpose.

I. Type of shoot.—The *age* of the bush from which the shoots are taken makes no difference in the rooting or growth of the cuttings ; the condition of the bush naturally has an effect on the performance of the cuttings. The age of the *shoot*, within limits, has no great influence on the root initiation, but cuttings of shoots that have been allowed to grow for over 12 months are likely to show a marked tendency to produce flower buds which usually restricts growth. No differences have been observed in rooting between cuttings taken from shoots with a dormant or an active apical bud.

II. Type of cutting.—With regard to the type of cutting to be propagated it is advised to use "single-node" cuttings (consisting of 1 leaf and inter-node). "Half-leaf" cuttings—top half of nodal leaf cut off—allow a greater number of cuttings per unit area to be planted (Fig. 1). They root equally well, but their subsequent growth is less than that of cuttings with an intact leaf. "Double-node" cuttings (2 inter-nodes and 1 or 2 leaves), though potentially able to grow more vigorously do not usually give such good results as single-node cuttings, because they are more liable to be affected by adverse nursery conditions.

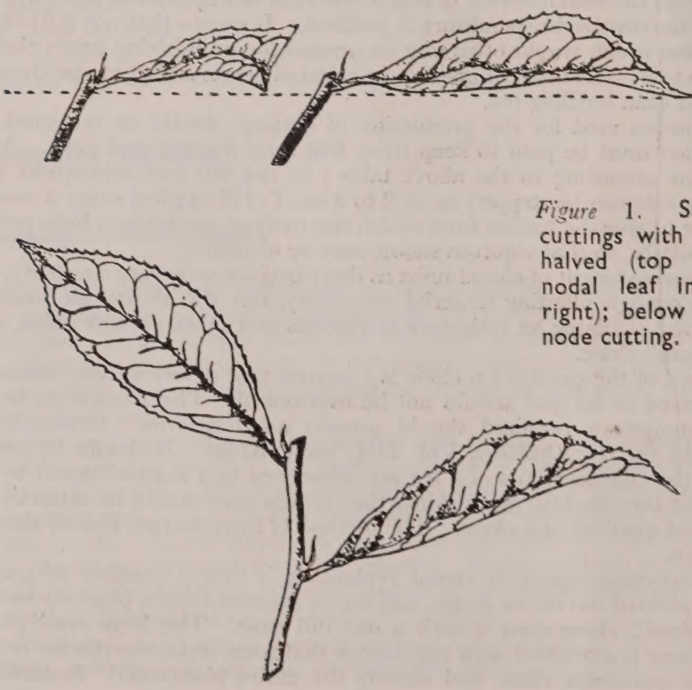


Figure 1. Single-node cuttings with nodal leaf halved (top left) and nodal leaf intact (top right); below a double-node cutting.

A cutting with the axillary bud starting to develop gives better results than one with a dormant bud. As regards cuttings the axillary bud of which has developed into a shoot with some leaves, the shoot must be cut back to the fish leaf as rooting may otherwise be hampered.

III. Preparation of cuttings.—The shoots are divided into cuttings with a very sharp knife, the tender apical portions together with the woody basal ends being discarded (Fig. 2).

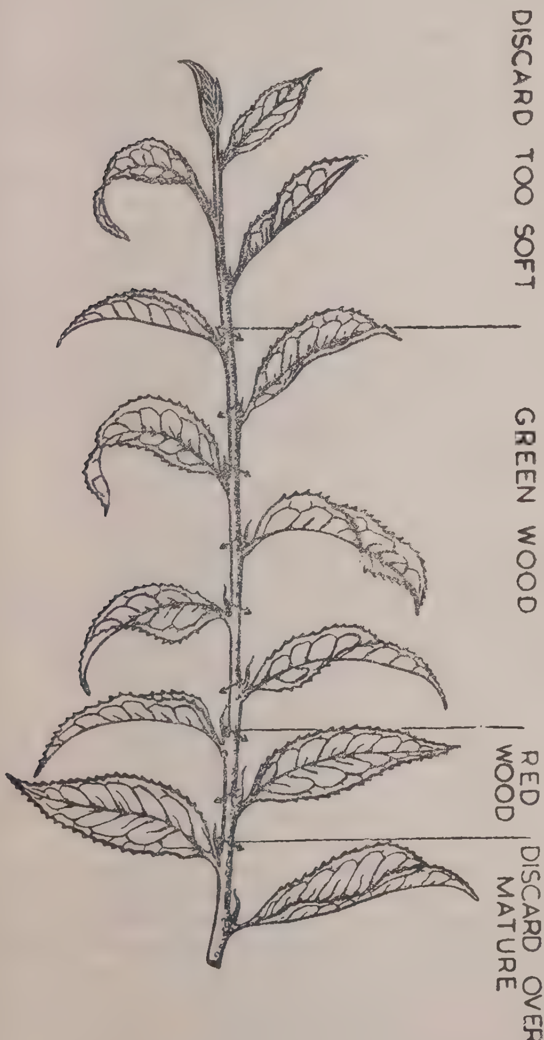


Figure 2. Cuttings to be used and discarded from a primary shoot.

It is important that this operation be done under shade and that the cuttings be left in water to prevent drying out. In making the cut, care should be exercised in not damaging the axillary bud, and anything in the nature of a ragged end or a bruised cut should be avoided.

Pre-treatment of cuttings of difficult rooting clones with several *growth hormones* both in their pure form and as commercial preparations has not given practical results so far.

For purposes of *transport* and *storage*, the shoots or the individual cuttings can be packed in bags of polythene tubular film. Stored thus under normal light conditions (not in sunshine) and at room temperatures they can be kept without harm for 1–2 weeks.

4.2 Nursery conditions

The essential requirements of a nursery site are :

> (1) good drainage, (2) a good textured soil, (3) correct pH, (4) absence of parasitic eelworms, (5) closeness to a water supply, (6) protection from winds, (7) proximity to the area to be planted.

The costs involved in obtaining these conditions are, to a greater or lesser extent, determined by the choice of the site for the nursery.

I. Rooting media.—A good rooting medium must permit, on the one hand good drainage, while on the other it should have a good water-holding capacity. The medium should not be rich in nutrients or manured before propagation as this would decrease rooting. It must also be free of decay-producing fungi and bacteria and contain no parasitic eelworms. With regard to the latter, *fumigation*, should be carried out as a routine measure at the start and subsequently once every year, unless the soil is definitely known to be free from eelworms. Fumigation can be done with either Nematox, Nemagon or Shell DD at the rates recommended by the manufacturers. A period of 4 to 5 weeks must be allowed to lapse after fumigation before the beds are used for planting.

If the same nursery is used intensively, its soil should be renewed or rehabilitated at least once in 1 or 2 years or a new site should be chosen.

With regard to nursery soils the following observations can be made :—

(*a*) *Guatemala soil :* Outstanding results can be obtained by using soil where Guatemala grass has been grown for a period of about 3 to 6 years. Such soils, the structure of which is usually excellent, contain large quantities of undecomposed roots which provide suitable aeration and adequate drainage. On certain estates *Mana grass* (*patna*) *soils*, if not eroded, and *jungle soils* have also been found to give good results.

(*b*) *Sub-soil* from between 3–6 feet below the soil level, is suitable when passed through a coarse sieve (about No. 4 mesh) and mixed with *peat* or with peat and washed river sand. The mixtures found to give good rooting were : 1 to 2 parts of sub-soil + 1 part peat and 1 part sub-soil + 1 part peat + 1 part sand. Sub-soil has the advantage that it is free from harmful organisms. The proportion of sand added should never be too great as it increases the pH unfavourably.

(*c*) *Tea soils*, even though having a reasonable structure, do not give results as good as those obtained from Guatemala soil or the above mixtures.

(*d*) *Saw dust*, *coir dust* and *expanded mica* were found to be unsuitable.

(*e*) *Soil acidity :* For optimal results the pH should be in the neighbourhood of 5.0 and preferably lower ; a pH higher than 5.5 is definitely harmful. An adverse pH reaction of the soil may be rectified by mixing the soil with flowers of sulphur. The rate of application varies with different types of soil, but as a general rule between 1 to 3 oz. per square yard, or between 1/3 to 1 lb. per cubic yard of bulked soil, should be satisfactory. The sulphur should be thoroughly mixed with the soil and the treated soil well watered for about 6 weeks, when planting can be done. A pH which is not too high can be also reduced by the addition of peat which improves the condition of the soil at the same time.

II. Preparation of the beds.—The preparation of the beds consists of loosening the earth to about 15 inches deep, removing stones and roots and breaking down the lumps. Drainage may be effected by providing the base of the bed with 2 or 3 inches of small metal or gravel. The depth of this layer will depend on whether the bed is used for callusing or rooting only (6″) or whether the rooted cuttings are to be left in the bed (12″–18″). The bed is then filled with the removed soil or with other suitable soil or soil mixture, to a height of about 6′-9″ above path level. The provision of a drainage layer to soils (*e.g.* sandy soils) which already are well drained can be disadvantageous during dry weather.

After the prepared beds have been allowed to settle they must be pressed before planting. The degree of pressing depends on the soil and the weather conditions during propagation.

During dry weather propagation a loose friable soil needs more pressing than a heavy soil or when propagation is carried out during the wet season.

III. Planting.—The prepared cuttings are inserted into the soil up to the axils of the leaves in rows across the beds and at such an angle that the leaf lies flat on the surface of the soil. The leaves should point in the direction of the wind ; the soil around the stem should be pressed firmly.

It is important that the basal ends of the cuttings do not become damaged in the process of planting. This can be obviated by the use of a dibbler to make holes prior to planting, but care should be taken to avoid leaving air pockets at the base of the cuttings by pressing firmly. When planting is done in dry weather the beds must be lightly watered beforehand, and planting must be carried out under shade.

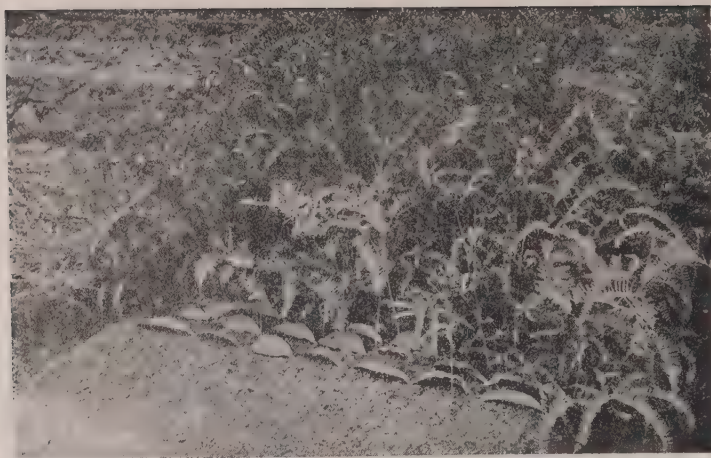
The cuttings can be spaced closely about 3½″ between rows and about 2″–2½″ in the rows, if they are to be transferred into baskets after they have rooted. However, if they are to be left longer in the beds and transplanters are to be used, it is then necessary to space the cuttings at least 5 to 7″ apart.

4.3 Shading and watering

It should be realised that shading and watering are interdependent ; a densely shaded bed requires less water than one which is not so heavily shaded. Over-watering and over-shading are equally harmful. The former will impede aeration causing poor rooting and rotting ; the latter will hamper the photosynthetic processes of the leaf leading to decreased growth and possibly the death of the cutting. One should not forget that both shading and watering are only required to keep the soil and the atmosphere under the shade reasonably humid and cool in order to prevent wilting and sun scorch.

With regard to weather conditions, it may be remarked that propagation during monsoonal weather is usually less successful than during dry weather because of excessive rain and unfavourable light and temperature conditions.

The *shading* of the cuttings must be done almost immediately after planting, as a few minutes' exposure to intense sunlight can cause damage. One method of providing shade is with bracken fern (*Gleichena linearis*) which is inserted in clusters into the bed between the leaves and along the sides of the bed. The shade should be fairly dense, so that the cuttings are hardly visible from above. (See Fig. 3).



Improper way of shading

Proper way of shading

Figure 3. Shading of cuttings with fern.

A more efficient, though more expensive system of shading cuttings is the use of iron or bamboo hoops covered with open-weaved coir matting. (See Fig. 4). Mesh widths ranging from about 1/8″ to about 1/2″ provide adequate shade (15-25% light intensity), the mesh width depends on local climatic conditions. Some of the advantages of using coir are that it can be used repeatedly and that it provides known and equal light conditions over the whole bed, while facilitating nursery operations.

Under extreme conditions of temperature and humidity, the height of the shade above the cuttings should be increased or a " double shade " may be employed. The latter method involves the use of a semi-permanent " overhead " shade, 5 to 6 feet high, which must permit a fair amount of light (40–50%). The cuttings themselves can be lightly shaded with fern.

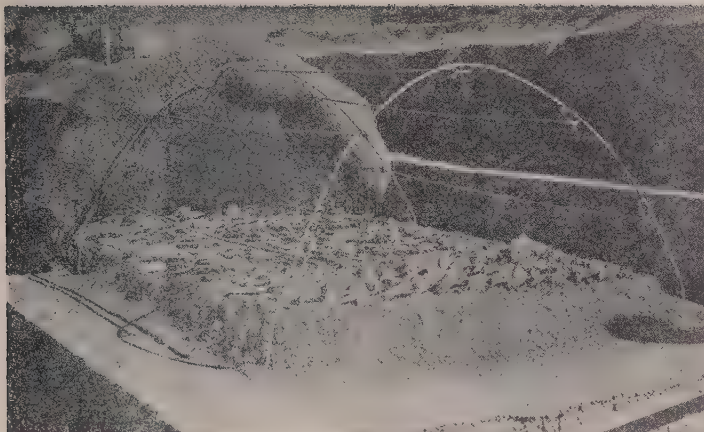


Figure 4. Shading of cuttings with coir matting.

With respect to *watering* it was found for coir shaded beds that a daily quantity of 0.25–0.40 inches of water given in two applications was sufficient during *dry weather*. The amount of water needed depends to some extent on the type of soil used for propagation, a heavy soil needing less water than a light soil. Watering, apart from being dependent on shading and soil conditions, also depends on the climatic conditions. During dull or rainy weather little or no watering should be carried out ; rainfall should be considered as water application. Generally, watering should be done before the soil under the shade shows indications of getting unduly dry.

For large nurseries a system of overhead sprinklers may be worthy of consideration as an efficient method of water application.

It should be mentioned that once the cutting has rooted, less water and more light are required. The latter can be provided by the thinning out of the fern. In case coir is used the sides of the beds can be left open or the original dense coir can be replaced by coir of a wider mesh (*e.g.* 3/4″ or 1″).

4.4 Pests and their control

As certain pests are liable to occur under nursery conditions, even though selection on resistance has been carried out, the control of the most common ones is given below.

Pests in nurseries and their control

Pest	*Control Measures*
Tea Aphids	Spray Nicotox " 20 "—1 oz. in 2 gallons water. One application.
Thrips	Spray 50% DDT—1 lb. in 25 gallons water. One to two weekly applications.
Scale Insects	Spray Nicotox " 20 "—1 oz. in 1½ gallons water. Three weekly applications.
Yellow & Purple Mites ...	Spray Thiovit or Spersul—1 lb. in 25 gallons water. Two weekly applications.
Scarlet Mite & Red Spider ...	Spray Thiovit or Spersul—1 lb. in 25 gallons water. Three weekly applications.
White Grubs & Cut Worms	Pour Intox " 8 " or Chlordox—6 pints per square yard, dilution 1 : 2000. One application.

5. Treatment of rooted plants

5.1 Soils and Manuring

I. Soils.—The use of baskets for rooted cuttings entails the choice of a soil suitable for growth. The choice is less limited than for propagation, as the soil may be rich in nutrients and the pH conditions may be less exacting.

Guatemala soil proved again to give excellent results when used for this purpose, while good *patna* or *jungle soil* are also suitable.

A suitable alternative in case the above soils are not available is provided by *sub-soil mixed* with well broken down compost or with peat and sand. Likewise, sub-soil mixed with tea fluff (5 : 1) provided a good mixture for basket plants, but the tea fluff should be allowed to decompose in the mixture before it is used.

The use of tea soil may not be advisable on account of the possibility that it contains toxic factors.

It is essential that basket soil be fumigated should parasitic eelworms be present in order to prevent their dissemination in the field.

II. Manuring.—In all the above instances the soils should be manured as soon as the cuttings have rooted, whether or not they are transferred into baskets. It is our experience that it makes a considerable difference to their subsequent growth. They can be manured with an organic mixture such as Sterameal A or other organic fertilisers of similar composition, at the rate of 2–4 oz. per square yard two-monthly. For young plants in baskets, a two-monthly application of 2 oz. Sterameal for about 20 plants is sufficient. The first application should be given soon after transferring into baskets.

Alternatively, manuring can be carried out with T. 175 mixture at the rate of 1 oz. per 20 plants every month. This has the advantage that it can be more quickly applied by using it mixed in water. Plenty of water should be used in order to prevent scorch ; the manuring rates can be increased with the age of the plant.

5.2 Transplanting

Once the cuttings have rooted two procedures can be followed : (*a*) they can be transferred into baskets, or (*b*) they can be left in the nursery (provided they were widely planted) until they are big enough for direct transfer to the field.

Whether "basket plants" or "ex-nursery plants" should be used depends largely on climatological conditions and the environment in which the plants have to grow in the field. The use of baskets is advisable if the transplanted plants are liable to be subjected to periods of drought, and also if they are used for resupplying or for planting in a rather poor soil. Plants directly transplanted from the nursery into the field particularly under circumstances described above have less chances of survival than basket plants.

Ex-nursery plants can be transplanted in two ways: (1) the plants can be removed with a suitable transplanter or, (2) they may be forked carefully out of the beds and then put out as stumps. These methods are cheaper than basketing and have the added advantage that less soil is required. It is often practised in areas where rainfall is well distributed, but it will be less successful in areas with adverse weather conditions.

As regards the time a plant is put out into the fields, the size rather than the age should be the main consideration in determining this. Generally, cuttings propagated under good conditions can be transferred into baskets 3 to 5 months after propagation started. Under suitable conditions both basket and ex-nursery

plants should be ready to go out into the field within 8 to 11 months after planting. If they are, however, to be grown under unfavourable conditions or at very high elevations where growth is slow, it is advisable to use somewhat older plants.

5.3 Bringing into bearing

It is important to start early on the shaping of the young plant to a suitable frame. Basket plants that carry about 10 leaves should be thumbnailed once, leaving 3 to 4 leaves on the plant. This cut will encourage early branch formation.

Ex-nursery plants can be treated likewise in the bed, but should receive a light cut—in order to reduce transpiration—before transplanting into the field.

Plants which are used for resupplying vacancies in old or nearly full grown tea must be allowed to grow without interference for several years after they have been put out, otherwise their chances of survival are remote.

Normally after the plants have been established in the field, either thumbnail pruning (in moderation) or layering should be resorted to. Centering should normally be avoided as it delays growth and, if done when the plant is still young, renders it more liable to succumb to adverse conditions.

5.4 Planting operations

The normal practice is to cut the holes or trenches in advance of planting. Consequently, they are often left open for one or more weeks before the plants are put in. This should be avoided as the holes or trenches may become filled with water and the walls "glazed." It is better to cut them in advance and fill them up with good soil, preferably mixed with compost or manure (*e.g.* 10 lb. per hole), immediately after or within a few days. The centre of the hole should be marked with a stick. This procedure has the advantage that the soil will have time for settling down and the compost or manure mixed with it will have decomposed to some extent. It also enables the plants to be put out at any suitable time, as the cutting of fresh holes, no larger than what is actually required, can then be easily carried out.

The planting must be done in *contour* hedges. The planting *distances* will depend on the growth habit of the clone, the condition of the soil and the steepness of the land. Spacing distances of between $1\frac{1}{2}$ and $2\frac{1}{2}$ feet in the row and from $4\frac{1}{2}$ to $5\frac{1}{2}$ ft. between rows are recommended. The aim should be to plant about 5000 bushes per acre.

THE IMPROVEMENT OF QUALITY

E. L. Keegel

Time and again in recent months we have heard it said or read that if tea is to hold its own against other beverages, which are increasingly becoming popular, it should be well made, clean and of good quality. By this is meant that if tea is to find a ready market it must conform to a certain standard of quality. When the term quality is loosely used in this connection it must be taken to refer to a combination of all the good qualities for which tea is consumed, namely, aroma, flavour, colour, strength and so on. It may even include the appearance of a tea. On the other hand there is a certain distinctive and desirable character present in most high grown teas, a few mid-country teas, and very rarely in some low-country teas, which is also called quality. When used in this sense it serves to distinguish quality from other liquor characteristics. In this article, the term quality frequently appears, meaning either (1) all the useful attributes of a tea, or (2) that unmistakable 'quality' which is mostly confined to a high-grown Ceylon tea, and the reader should therefore have no difficulty in interpreting the term whenever it appears in the context.

For some time after the last war a vigorous and concentrated effort was made towards improving the general quality of Ceylon teas but a decline appears to have set in of late and today there seems to be inadequate supplies of good tea. There are signs that less concentration is being paid to the standard of plucking. Whether this has been the main cause or whether it is the result of over-production, heavier manuring, lack of factory equipment, or less attention to manufacture it is impossible to say. Whatever may have been the contributory factor, the fact remains that the buyer, with whom is associated the consumer, is more discriminating today than ever before. His requirements have to be satisfied or at least partly met if the producer wants a better price for his tea.

In an age of television and colour advertising, the consumer's first thought naturally turns to the colour of a beverage, and it is only natural that today more emphasis is being placed on colour of a tea liquor. Another desirable feature is strength, and the popularity of quick-brewing blends which make a packet of tea last longer is evidence of the consumer's desire for an economic tea. In the case of a high-grown tea, which by its nature is not sufficiently coloury and strong to bring it into a special category, its quality is the more important consideration.

Contrary to general opinion, tea is valued on the London market partly on its appearance and a really well-made tea with a relatively poor liquor may fetch as much as a tea with a poorer appearance but better liquor. Generally speaking, it is the liquor which scores. Yet the fact that stalk has such a lowering value on a tea calls for the most serious consideration on the part of the producer. Whether justifiable or not, the presence of stalk in a tea is not favoured by the trade and is always associated with inferior liquors. The standard of plucking should therefore be as high as possible commensurate with cost of production and yield in order to satisfy one of the main requirements of the trade. Not only is stalk not favoured but a grade should not be ragged, *i.e.* consisting of different shapes and sizes. It would not matter if it is a little brownish or flaky so long as it is uniform in size. Whether

it needs to be cut or not by a blender attention is still paid to a tea with good style and uniformity and the maintenance by an estate of a uniform standard of leaf appearance.

Unless the highest possible standards in liquor and appearance are maintained Ceylon tea may find it difficult to defy competition not only from other beverages but from tea produced in other countries. The quality of African teas appears to be steadily improving and with new factories being built and selection work expanded, the time is not far distant when teas from these newly developed areas would prove a serious challenge. Indian teas made by the C.T.C. process are steadily gaining ground, and with China now contemplating export, not to mention Argentine which has already entered the market, an improvement in the quality of our own teas is most essential today.

The tea industry in Ceylon has far too long maintained an attitude of lofty indifference to the potential capabilities of other tea producing countries and can no longer afford to ignore the present situation. If no action is now taken to improve the standard of its teas, the reputation Ceylon has built up over the years may decline sooner than expected. The question of merely finding new markets for Ceylon tea is no answer to the problem; what is first needed is a higher standard of quality.

One of the factors outside our control which influences quality is of course elevation. Others are jât, season and the weather conditions associated with the latter, as evidenced by the noticeable difference between teas produced in dry weather and during a wet monsoon. Possibly other uncontrollable factors affect quality to a greater or less degree, but if it is not present in the leaf to start with it is quite impossible to introduce it in the factory.

Though quality happens to be an accident of location there are some factors within our control which can either impair or improve it before the leaf is processed. One method of improvement, for example, is by regulating the crop. The time and method of pruning and/or the time and method of manuring can be so adjusted to avoid phenomenal rush crops with poor quality but still without depressing the annual yield. It may not be possible in certain cases to bring about an even distribution of crop throughout the year by suitable agricultural practices, but where weather conditions are not abnormal it is an objective worth aiming at.

Another factor is the standard of plucking, and a laxity in plucking standards appears to be taking place arising chiefly from the desire to obtain yields of 1,000 pounds and over whatever the consequences, and from the comforting belief that mechanical stalk extractors provide the answer to the problem of eliminating excess stalk. This drift is only taking Ceylon tea further away from the good name it earned in the past and should be arrested before further damage is done to its quality.

Increased yield is of course a worthwhile proposition provided the right type of material is available, but an illusory gain is obtained from trying to increase crop by resorting to coarse plucking. It is well known that the coarser the pluck the greater the quantity of waste tea, all of which is of no value. If a good standard of plucking can be made to give 98 per cent of saleable grades from the total tea made, not more than 93 per cent can be expected from a coarse pluck. Would it not be more profitable to discard the coarser stalk in the field rather than to manufacture it and pay for withering it and all the other operations which follow, let alone its final elimination, which is not easily achieved ?

Appearance of a tea is still important and however efficient a stalk extractor machine may be, it can neither bring the appearance of poor leaf up to the standard of good leaf, nor can it improve the liquoring properties of such tea.

It is therefore evident that some sort of a planned system in the field is required if with existing material an improvement in quality is required. Apart from crop regulation, a control over plucking is needed. The latter does not only imply that coarse stalk and leaf should be avoided. Just as important as eliminating these undesirable components, is the keeping out of the factory of tough banji. Banji shoots should be plucked before they become too mature.

Spectacular results cannot of course be obtained by merely having the right type of leaf for manufacture; adequate and suitable equipment must also be available for manufacturing it. But how many factories have within recent years been expanded to cope with increased yields ? Unless increased and better equipment is provided, crop should be carefully controlled and it may even be found necessary to rest uneconomic areas or throw them out of production. It is useless blaming high manuring for poor quality teas if in the first place no effort is made to plan the harvesting of the crop in relation to the capacity of a factory. There are still a number of people who imagine that no serious harm results from makeshift arrangements for the manufacture of 'rush' crops, but this is evidently a mistake because it is during a time like this when the leaf possesses a smaller proportion of inherent good qualities that greater attention is needed in manufacture. Because of the fact that owing to seasonal changes the same standard of quality cannot be maintained throughout the year, it is no excuse for a producer to be content with poor results during the off-quality season.

It would thus be seen from what has been said so far that quality cannot be cheaply earned. Let us see how we can manufacture the best possible tea that the leaf can produce.

With reference to a high-grown tea the main requirements are:—

1. the shortest wither economically possible, artificially or otherwise, without resort to temperatures exceeding the maximum day temperature,

2. avoidance of high temperatures during rolling and fermenting, but not neglecting the necessity to get the leaf warmed up as soon as possible in the rollers by adequate pressure in order to get fermentation started,

3. obtaining a uniform dhool and of the size of a B.O.P. grade—whether by double roll-breaking or any other means,

4. care in not exceeding a period of fermentation of 3 hours for early dhools and 4 hours for later dhools,

5. a firing temperature not exceeding 195°F, and a moisture content not higher than 3 per cent,

and 6. a clean factory.

It is very unlikely that any up-country factory will find itself in difficult straits by observing the foregoing points. Nevertheless, it should be recognized that to attain a high standard of quality in the tea, the properties essential to its development should be present in the green leaf. For more details on the improvement of quality the reader's attention is invited to Monograph No. 4. In an article of this length only the fundamentals can be indicated, but at the same time it may be found useful to

refer briefly to some other aspects of manufacture in relation to the particular type of tea a factory may wish to turn out. The difference in character of the raw material entering the factory must naturally have an effect on the final product, and it is necessary to bear this in mind when considering the following discussion.

Withering

The characteristics of a tea produced from long withers are too well known to call for repetition. A few estates undoubtedly have obtained remarkable success probably because such teas have been needed for a particular purpose, and in the case of an estate which has established a 'mark' for strong, coloury teas a change would not be advisable with a view to improving 'quality'. Likewise, an estate with a 'mark' recognized for its 'quality' has nothing to gain by extending the period of wither, since even short periods of fermentation do not correct the loss of quality brought about by long withers. However, in some instances it may be found advantageous to extend the period of wither of say the evening leaf only when rolling methods have failed to get sufficient colour and strength, but a lack of briskness in the liquor is inevitable.

Soft withers still continue to be taken by some up-country factories, with unsatisfactory results, in the belief that they will improve the colour of the infusion and liquor. It cannot be gainsaid that during the dry weather exceptionally good pungency and flavour may be obtained from under-withered leaf, but considering that liquors are harsh and the teas brown and very flaky, there is a strong case for taking good withers under normal conditions. There is no evidence to suggest that infusions get duller or colour declines with harder withers if rolling is properly carried out. For the conservation of flavour when all that matters is the shortest wither possible, a little under-withering will do no serious harm.

Rolling

Quite a number of unsuspected defects in rolling are caused by loose pulley belts and shortage of power. Lack of proper organization is also another major contributory factor, and unless these are corrected in the first place the best results are never likely to be obtained.

With respect to the main groups of teas made in Ceylon, a criticism often levelled at some high-grown teas (particularly Nuwara Eliya's) is that they are too thin. It seems more than probable from the results of recent investigations on the effect of age from pruning that the long pruning cycles in practice in such districts may be one of the contributory causes of this characteristic property of these teas. It has not yet been definitely established that with increasing age from pruning quality progressively improves, and it may very well be that with shorter pruning cycles Nuwara Eliya teas would be more valuable with improved colour and strength. It is quite impossible of course even by harder rolling to bring such teas into the category of coloury teas because by their very nature they tend to be light, but it is possible that by harvesting softer leaf more body can be introduced.

For places in the mid-country that do not make a very good quality tea, one matter very difficult to decide is whether liquor should be sacrificed for appearance or *vice versa*. Elevation and jât must in any case be the first consideration, and the number of rolls adjusted accordingly. Where some doubt exists as to whether 4 rolls or 5 rolls is preferable, assuming the initial rolls are carried out in such a way as to conserve appearance, it is suggested that (*a*) for mainly appearance only 4 rolls be carried out to give 20-25 per cent B.B. (*b*) for liquor, an additional roll be carried out to reduce the B.B. to 10 per cent.

One very serious shortcoming in most Ceylon low-growns is that though they possess some colour, they lack the necessary strength to command a better price in the London market. Those low-country estates manufacturing teas for this market would therefore be well advised to make a radical change in their rolling, which for a long time had appearnace only as an objective. The uncertainty of the Middle East market and changing tastes, may also result in black, tippy teas with poor liquoring properties being of little value in time to come.

The emphasis on colour and strength has led to the adoption of continuous rolling on many estates, one method being to roll the big bulk continuously and the other the replacement of dhool with an equivalent amount of withered leaf. There are two disadvantages in the former method: (1) no proper control of fermentation of the later dhools, and (2) excessive heat resulting from the rolling of combined charges.

The importance of having a large roller for amalgamating charges need hardly be stressed, and the only circumstances which justify the adoption of this method is inadequate equipment to reduce the B.B. outturn to a reasonable figure. As regards the continuous rolling of withered leaf due care should be taken to have a good standard of leaf and a good wither, and to avoid the following pitfalls:—

1. an excessive initial charge,

2. insufficient dhool outturn,

and 3. over-fermentation.

Roll-Breaking

A roll-breaker plays a most vital rôle in manufacture, but it would appear that this machine is still taken too much for granted. A lengthy chapter has been devoted to the subject of roll-breaking in Monograph No. 4, and it is quite unnecessary to go over the same ground again beyond stressing the points that size and uniformity of dhool are the two major considerations. The extra care taken over this process will be repaid many times over since the final characteristics of a tea depend mainly on the size of dhool taken out and its degree of evenness. If the mesh is incorrect it should be replaced, and if the correct type and size of dhool is still not obtained, double roll-breaking should be carried out. If at all experimentation is needed in a factory, there is no more useful machine to start on than the roll-breaker. Few tea-makers even today realize its importance and understand its main function.

Fermentation

A tea taster's first criterion is colour and brightness of a liquor—a dull liquor is rejected. Yet too much attention still appears to be paid to the infused leaf which is out of all proportion to its importance, with the result that in attempting to correct a greenish infusion over-fermentation is brought about. Heating of fermenting rooms is one of the methods employed. Another is extending the period of fermentation and a third method, thickening the spread unduly. All these sometimes prove of no avail and quality is sacrificed.

One essential requirement for fermentation is warmth and this can easily be overdone by the methods frequently practised. All that is required is generation of sufficient heat in the rollers in the early stages of rolling to provide the necessary heat for fermentation to start. Delay in doing this will result in loss of quality.

A matter that still puzzles many is the correct order of firing dhools. From the evidence now available it would appear that for heavy rolling, firing the early dhools first is the most suitable. Where rolling is light in the early rolls and a greater proportion of the initial charge is carried over to the 4th and 5th rolls, it would be better to start with the last dhool. In any case the period of fermentation should not exceed 3 hours at the time any particular batch is first taken to the drier. Should the required liquoring properties not be obtained with this fermentation, then obviously something is wrong either with the leaf or the method of rolling.

The period each dhool should be fermented varies of course with individual circumstances and the type of liquor required, but it is always necessary to remember the close relationship which exists between colour and quality. Since the early dhools have the most quality, it is particularly important that in the case of high-grown teas they should not be over-fermented. It is possible now in the light of further results obtained on fermentation, to give some guidance on the matter, and the following data may be of assistance:—

		Minimum	*Maximum*
Dhool 1	—	2 hours	3 hours
,, 2	—	2½ ,,	3½ ,,
,, 3	—	2½ ,,	3½ ,,
,, 4	—	3½ ,,	4½ ,,

The lower figures are recommended for the conservation of quality and the higher ones for the development of colour. A period of fermentation somewhere between these two would probably give the best all-round tea. However, they should be checked in each individual case by observing the cup characteristics of each dhool.

In practice it will not be found possible to give each dhool its optimum period of fermentation for the simple reason that, when only one drier is being used, one dhool should follow another to keep the drier fully loaded. But in the case of a factory using 2 driers more flexibility is afforded and more opportunities exist for obtaining the most suitable periods. For example, instead of dividing the dhools between two driers at the same time, as is customarily done, two different dhools may be fired simultaneously. Another possible modification is to bring one drier into operation later than the other. Thus by the latter expedient the overall period of fermentation can be radically altered without in any way upsetting the rolling room organisation.

Firing

There appears to be a smug satisfaction that if the exhaust thermometer during firing reads between 120-130°F there is nothing to worry about. Frequent cases have come to light where owing to unsatisfactory conditions under which a drier is being operated, a recorded exhaust temperature of 125°F has proved to be very unreliable. Erroneous exhaust temperatures can arise from a number of causes such as:

1. excessive air speeds
2. uneven distribution of air
3. empty trays
4. uneven spreading

5. faulty thermometers

6. thermometers incorrectly placed.

It is not always that a drier is without any of these shortcomings. Hence it is most important that entire reliance should not be placed on the exhaust temperature. Moisture contents should be checked occasionally. For correct firing, tea leaving the drier should not have more than 3 per cent moisture.

This brings us to the question of moisture meters of the infra-red type, and the warning is given to estates to ascertain before they purchase such instruments the actual conditions under which they should be operated. The correct height between lamp and pan, and the time of drying should be clearly indicated by the suppliers and not left to the estate to determine by experimentation. Since none of these instruments can give a true reading over such a wide range of 1-7 per cent moisture for a fixed position of the lamp and a fixed drying period, it is certainly desirable to have a calibration chart with each instrument.

Grading

How does grading affect the general quality of a tea ? One of the ways is excessive handling, which includes sifting, cutting, picking and winnowing. To reduce these operations to a minimum we return again to the importance of having a good standard of leaf, a good wither and proper rolling. Restriction of off-grade outturns without relation to the standard of plucking can also obviously affect liquoring properties of all the main grades. Besides, the indiscriminate use of breakers and stalk extractors can have a very adverse effect—more than what is generally believed—and it appears likely that the present craze for reducing picking costs may do more harm than good. The misuse of these machines and the temptation to pluck coarser because of their availability may well spell ruin to Ceylon quality.

The appearance of a tea still counts and although the present trend is for teas of smaller size, there is no justification for any factory to carry out abnormal methods for increasing the outturn of the fannings grade unduly. In the London market small B.O.Ps are acceptable because even when mixed with fannings they do not make much of a difference to the uniformity of a blend. Most blenders try of course to avoid as much cutting as possible because of the adverse effect on liquoring properties and the formation of dust; and that is why fannings types have a ready market. But it does not follow that by excessive cutting up of teas in a factory the fannings produced will be more valuable than a well made B.O.P. True grading is now a thing of the past, but let not the B.O.Ps and fannings deteriorate still further to the detriment of Ceylon teas.

It is hoped that the foregoing suggestions will help the producer to ensure the highest standard of manufacture in these difficult times of competition, but it needs to be stressed again that only the best type of leaf can produce the best quality.

Summary

1. To command a good price, teas must conform to a certain standard of quality, which includes appearance.

2. Stalk has a definite lowering value on a tea, and its elimination requires the most serious consideration of the producer.

3. A higher standard of quality is required of Ceylon tea if it is to meet competition from other tea producing countries in the future.

4. The current tendency to obtain 1,000 lbs. yields and over would lead to a deterioration in quality if steps are not taken to regulate crop in relation to factory equipment.

5. Quality cannot be cheaply earned. The properties essential to its development should be present in the green leaf; the standard of plucking should be good and the right equipment available in the factory.

6. To make the best possible tea from high-grown leaf the essentials are short withers, short fermentation, avoidance of unduly high temperatures in rolling and fermenting, dhools of small and uniform size, correct firing and a clean factory.

7. Manufacture in general:

(*a*) *Withering.*—It is best to avoid long withers unless an estate has established a 'mark' for the particular type of tea resulting from prolonging the wither.

(*b*) *Rolling.*—The adoption of continuous rolling calls for a good standard of leaf and a good wither.

(*c*) *Roll-breaking.*—Size and uniformity of dhool are two major considerations.

(*d*) *Fermentation.*—Too much attention still appears to be paid to the infused leaf and in many cases over-fermentation has resulted from attempts to correct greenish infusions.

(*e*) *Firing.*—Entire reliance should not be placed on exhaust temperature readings. Moisture contents of the fired tea should be checked.

(*f*) *Grading.*—Excessive cutting and indiscriminate use of stalk extractors should be avoided.

THE CHEMISTRY OF TEA MANUFACTURE

M. S. Ramaswamy

The chemical changes that occur in the various stages of tea manufacture were, until recently, imperfectly known. Research in this direction would help not only in improving the existing methods of manufacture, but also in the solution of any fresh problems as they arise. In order to render the present manufacturing practices scientific rather than empirical, a thorough knowledge of the chemical and physical changes that take place during the various stages of its manufacture is very essential. The chief constituents of tea are, caffeine, tea catechins, pectins, proteins, carbohydrates, leaf pigments, vitamins, essential oils and mineral matter. Our present knowledge of these constituents of tea and the changes that they undergo during the processing of tea is briefly summarised in this article.

Caffeine

One of the principle constituents of tea leaf is the alkaloid caffeine which is a tasteless substance accounting for about 3-4 per cent of the dry matter. This alkaloid is also present in other vegetable sources like coffee, cocoa, cola, etc. About 80 per cent of the caffeine in black tea is soluble in the five-minutes brew. Nearly 60 per cent of the soluble nitrogen in tea is derived from this constituent. Caffeine does not undergo any change during the processing of black tea from green leaf. During firing, partial sublimation takes place and a very little of it is deposited on the roof of the driers.

Tea Catechins

Tea catechins are the most important constituents of tea and are responsible for the colour, pungency and characteristic taste of tea liquors. In the green leaf they are colourless, water-soluble compounds and constitute between 20 to 30 per cent of the dry matter. Until recently very little was known about their composition. Tea catechins (or tea polyphenols) are quite distinct from the substances used in the leather industry, such as oak gall tannin or tannic acid, which are powerful protein precipitants. The tea catechins are sometimes referred to as gallotannins. Much harm has been done as a result of the confusion of these two distinct groups of tannins so far as it concerns the effects of tea tannin on the human system. Tea catechins are quite harmless in this respect. A number of tea catechins have been separated into individual pure substances and their identity established. The most important of these are catechin, epicatechin, gallocatechin, epigallocatechin, epicatechin gallate and epigallocatechin gallate. Of these, it has recently been shown by Roberts* that the last three, and particularly epigallocatechin gallate are present in greatest amounts in tea.

Fermentation of tea was, for a long time, considered to be due to microbial activity, but recent research has established beyond doubt that it is caused by enzymic reactions of an oxidase (oxidizing enzyme) present in the green leaf. It is

* Roberts, E. A. H., (1958). J. Sci. Food Agric., **9**, 381.

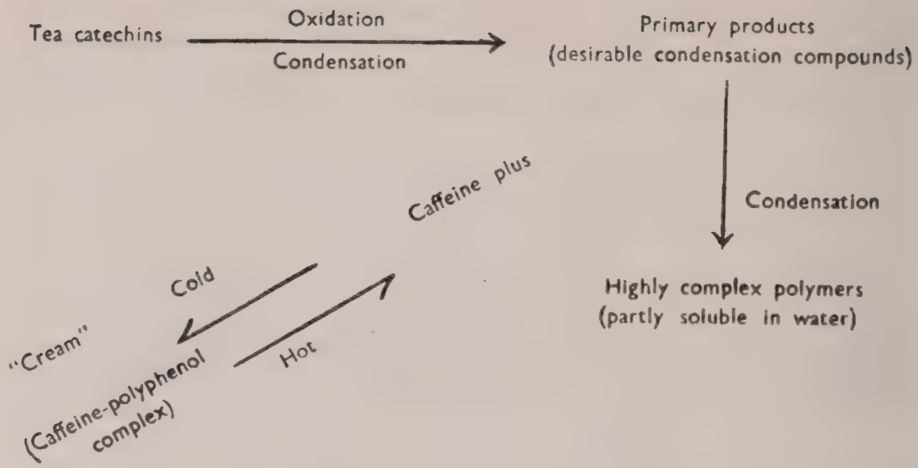
common knowledge that when an apple or a potato is cut and exposed to air, the cut portion assumes a brownish colouration after some time. On the other hand, if the potato or apple is dipped in boiling water before cutting discolouration is inhibited or at least very greatly retarded. This discolouration is due to the presence of oxidising enzymes in the fresh product which is sensitive to heat. A similar reaction occurs when tea leaf is ruptured in the rolling process.

Tea catechins, like most other polyphenolic compounds, have a large potential capacity for absorbing atmospheric oxygen and thus becoming oxidised. For this reason the polyphenol pyrogallol, which absorbs oxygen completely, is actually used for the determination of oxygen in mixtures containing the gas. But the absorption of atmospheric oxygen by tea polyphenols is normally very slow. In the presence of enzymes (biological catalysts) present in tea leaf, however, the rate of oxidation is very rapid. The tea catechins and the oxidising enzymes are present in different parts of the leaf cell; consequently, as long as the leaf is undamaged oxidation of the catechins does not take place. However, oxidation commences in leaf damaged during transit from field to factory, forming dark brown streaks at the site of the bruise.

Tea catechins do not appear to undergo any change during withering. The biochemical changes actually commence in the rolling process, one of the main functions of which is to rupture the cells of the leaf and to wring the leaf juices out of it. The catechins come into contact with the oxidising enzymes and start absorbing oxygen rapidly from the air and become oxidised. Some of the oxidised catechins polymerise almost instantaneously and then condense to assume gradully the characteristic coppery reddish-brown appearance of the fermented material. In other words, the oxidised molecules of tea catechins rearrange themselves and join together in this process. The oxidised catechins do also oxidise part of the green pigment of the leaf chlorophyll. These biochemical changes are allowed to continue during the process of fermentation until the optimum degree of colouration is obtained.

One of the chief functions of the next process in tea manufacture, namely, firing, is to arrest the enzymic reactions of the fermenting leaf. Enzymes in general are very sensitive to heat treatment and their activity is completely destroyed at high temperatures. This property is made use of in the manufacture of green tea where the leaf is subjected to a process of steaming prior to its manufacture. Tea enzymes are destroyed as soon as the fermenting leaf is subjected to the high temperature of the driers. The moisture content of the product is reduced to about 3-4 per cent from about 50-60 per cent in the fermented material before firing.

The products of condensation of tea catechins present in made tea may be grouped into: (*a*) water soluble and (*b*) water insoluble constituents. The water soluble products may be further divided into (i) ethyl acetate soluble and (ii) ethyl acetate insoluble fractions. The *desirable* characteristics of tea liquors are derived mostly from that fraction which is soluble both in water as well as ethyl acetate. Roberts (*loc cit*) has recently shown that the colour of tea liquors is due to two groups of pigments (1) thearubigins which are rusty brown in colour, acidic in nature and constituting about a third of the dry matter of the extract, and (2) theaflavins which are golden yellow in colour, neutral in reaction and constituting about 6 per cent of the soluble matter. These are reported to bear a close relationship to the quality of tea. The ethyl acetate fraction combines with caffeine to form a loosely held complex which precipitates when the liquor cools down. Tea tasters term this phenomenon "creaming down" and part of their evaluation of teas depends on the amount of this "cream." The scheme of reactions that take place in the fermentation of tea catechins and the formation of the "cream" may be represented as follows:



In under-fermented and over-fermented teas, the primary products are present in lower amounts than in normal teas with consequent effects on creaming.

Pectic Substances

Pectic substances which chiefly include pectin and pectic acid account for nearly 4 to 6 per cent of the dry matter in tea. They are invariably present in all fruits and vegetable sources, but citrus rind is a particularly rich source of pectin. Pectic acid has the property of forming a gel in acidic media and this property is made use of in the manufacture of jams and jellies.

Tea pectins are partly broken down into pectic acid and methyl alcohol in the presence of another enzyme, pectase, or more correctly, the tea pectin methyl esterase. Damage to, or bruising of the leaf, during rolling starts this reaction as well which also continues during the process of fermentation. The reaction is arrested by the high temperatures at firing.

The tea pectin-pectin methyl esterase reaction appears to control the tea polyphenol-polyphenol oxidase reaction of the fermenting material to a large extent. The pectic acid formed in this reaction appears to form a gel in the acidic fermenting material which coats the surface of the latter. Such a gel coating impedes the free absorption of oxygen by the tea catechins and slows down the oxidative process. It also appears that the pectic acid gel helps in the retention of the characteristic twist assumed by the leaf during the rolling process.

Most of the methyl alcohol produced in the reaction is lost into the atmosphere, but it appears likely that part of it is held back by the leaf tissues and possibly converted into esters by combination with the organic acids of the leaf in the presence of an esterifying enzyme. The flavouring constituents of many food products are mostly esters.

Essential Oils

The essential oils of tea are mostly methyl esters of various organic acids and are present in exceedingly small quantities. Japanese workers obtained about half an ounce of these oils from about one thousand pounds of tea.

Chlorophyll and Other Pigments

It has been stated earlier that the oxidised catechins of tea in their turn oxidise part of the chlorophyll pigment of the leaf causing the disappearance of the greenish colour of the mass during fermentation. Part of the chlorophyll is also decomposed during firing. No change appears to occur to the carotenoid pigments during the various stages of manufacture.

Carbohydrates

The amount of carbohydrates in tea leaf is extremely small. These substances are broken down to water and carbon dioxide by the respiring leaf to provide the necessary energy for cellular activities. Respiration continues throughout withering and even during rolling and fermentation *undamaged leaf* continues to respire to some extent. It has been found that 1 to 2 per cent of the dry matter of the leaf is lost on account of respiration during withering.

Proteins

Tea contains minute quantities of proteins and amino-acids. Proteins are partly broken down to simple water soluble substances, the amino-acids, during withering. They do not appear to have any role in fermentation, nor do they appear to undergo any further change during the process of manufacture.

Vitamins

Tea leaf contains carotene (pro-vitamin A), ascorbic acid (vitamin C), and the vitamins of the B group riboflavin, thiamine and pantothenic acid. Carotene being insoluble in water is not found in the beverage, whilst vitamin C is completely destroyed during tea manufacture. The vitamins of the B group are not affected by the manufacturing process and are highly soluble in water. It has been found that a cup of tea contains about 27 ug riboflavin and 75 ug pantothenic acid. About 5 cups of tea provide nearly 5 per cent of our daily requirement of these vitamins.

Minor Elements

Tea contains minute quantities of copper, zinc, boron, aluminium, iron, calcium, manganese, magnesium and fluorine. Copper forms an essential part of the polyphenol oxidase and is therefore of vital importance for the fermentation of tea. About 25 per cent of the copper content of tea leaf is present in the enzyme system. This discovery was put into practical use in Nyasaland where it was found that teas grown in certain areas could not be fermented properly until they were sprayed with copper compounds. Their soils were found to be deficient in this element.

During the spraying of tea with copper fungicides for the control of blister blight it has been found that part of the residual copper is absorbed by the leaf and retained to some extent. When applied in great excess copper replaces some of the magnesium in the chlorophyll molecule, and the copper-chlorophyll formed being more resistant to oxidation by oxidised tea catechins than normal chlorophyll, leads to the production of greenish infusions. It should be mentioned however that greenish infusions are also the result of under-fermentation of tea leaf. Up to 20 per cent of the copper in tea is soluble in the brew. Minute quantities of copper are essential in the human diet for the normal functioning of the liver in the formation of blood.

Tea contains traces of fluorine part of which is soluble in water. It has been found that drinking water containing traces of fluorine is beneficial for the healthy growth of teeth and in the prevention of dental caries. The liquors from Ceylon teas can, therefore, be considered to have a possible beneficial effect for this reason.

THE ESTIMATION OF THEAFLAVINS AND THEARUBIGINS IN MADE TEAS*

E. A. H. Roberts

As a result of investigations into the chemical composition of made tea it has been established that the coloured oxidation products extracted in the liquor represent a comparatively simple mixture of substances. Nearly all the colour is due to two classes of substances, neither of which have been previously recognised by chemists; and it has been suggested that these should be referred to as *Thearubigins* and *Theaflavins*.

The thearubigins—literally the rusty-brown substances found in tea—account for more than 10 per cent of the total dry matter in tea. There appear to be several closely related substances in this class.

The theaflavins are the substances responsible for the golden-yellow element of colour. There are two theaflavins, theaflavin and theaflavin gallate, both of which have been obtained as pure chemical substances, and together they account for up to 2 per cent of the dry weight of tea. It has been shown that the theaflavins undergo further oxidation during fermentation, and that this further oxidation results in the production of thearubigins.

Relationships to Liquor Characters

As already mentioned, the thearubigins and theaflavins together are responsible for almost all the colour of a liquor. The taster's assessment of colour must therefore be in terms of these two groups of substances. Both contribute to the depth of colour, but tone is largely dependent upon the amount of theaflavins. Good colour is associated with a high sum total of thearubigins and theaflavins and with a relatively high ratio of theaflavin to thearubigin.

Other liquor characters are also explainable in terms of these two groups of substances. Thus strength appears to be a property both of theaflavins and of thearubigins and is usually proportional to their sum total. Provisionally it has been concluded that briskness is due to a combination of theaflavins with caffeine. Quality is a rather complex character, but it appears probable that the theaflavin content is one of several factors concerned.

Analytical Estimation

We have been successful in developing an analytical method, involving the use of a spectrophotometer, for determination of the amount of both theaflavins and thearubigins in liquors. This method gives an accurate measure of the depth and tone of colour. As already indicated these values are also connected with factors such as strength, quality and briskness. The measurement of theaflavins and

**Reprinted from "Two and A Bud," Vol. 5, No. 3, September 1958, pp. 11-12, with the kind permission of the Editor.*

thearubigins in a liquor therefore gives a considerable amount of information about the tea concerned, although it is not claimed that these measurements tell us all we wish to know—for example the method tells us nothing about flavour or second flush quality.

Compared with tasting these results are both more accurate and more reproducible—a taster's palate is obviously less reliable than a precise scientific instrument. Further, the values obtained are not dependent upon fluctuations in the market, nor are they complicated by the fact that different tasters may be valuing teas for different markets.

Applications

For experimental work on tea manufacture it is considered that this new method, with its much greater precision, will prove of considerable value. On the other hand it is still necessary to supplement these results by the usual tasting reports. For routine evaluations of commercial teas it is considered that the normal tasting procedure will continue to be adequate. Tasting, compared with the new analytical method, is more economical both in time and in cost. However where tasting reports are conflicting, or when a garden wishes to rectify faults in manufacture, following an adverse report, it is considered that the tasting may well be followed by chemical analysis. The two methods of assessing a tea, tasting and analysis, are therefore complementary to each other.

In the orange grades of conventionally manufactured teas we have clear cut evidence that the best valuations are given to teas with a high sum total of theaflavins and thearubigins, and with a relatively high ratio of theaflavin to thearubigin.

On the arbitrary scales at present in use a good tea gives a theaflavin figure of 0.7 or over, and a thearubigin figure greater than 2.0. In other words the theaflavins must be responsible for at least 25 per cent. of the colour. Really poor teas may have the same sum total of theaflavins and thearubigins but a theaflavin figure as low as 0.3. For C.T.C. teas very much higher figures are obtained for both theaflavins and thearubigins, the best of these teas are those with theaflavin figures of the order 1.2 and with thearubigins at 3.0 or even higher. It is interesting to note that a few tobacco cut teas gave equally high figures for theaflavins, which accounts for the extremely good colour they show in the cup.

The analytical figures for theaflavins and thearubigins have given acceptable explanations of effects of varying time and temperature of firing in valuations and liquor characters. It has also been shown that when teas of high moisture content are stored at high temperatures, the deterioration which sets in is largely due to a destruction of theaflavins. Further uses for the method have been found when examining the very marked effects of infusing teas with different kinds of water.

We are now occupied in developing a considerably simplified procedure which will be more suitable for routine analyses of made teas in laboratories less well equipped than that at Tocklai. Even this simplified method however will require a certain amount of chemical skill and, if this method is to be used outside a laboratory, it will be necessary to have men properly trained in its use and applications. It must also be once more stressed, that although theaflavins and thearubigins are of very great importance in determining liquor characters, there are other factors involved which must not be lost sight of. We have not yet succeeded in explaining the whole of what constitutes good tea in terms of pure chemistry, and it will probably be some time before this goal is more nearly approached.

ROLLER CONES

E. L. Keegel

One of the major problems in rolling is to get the maximum amount of dhool in the minimum time without sacrificing appearance and liquoring properties. Although it is very easy to get excessive dhool outturn it is by no means a simple matter to get the correct type of tea.

Scientific evidence has shown that most of the action in rolling takes place at the centre of the roller table. So it follows that the larger the central fitting the higher will be the dhool outturn, but there is obviously a limit to the extent to which the former can be increased in size. If the limit is exceeded, the fitting will not only reduce the potential capacity of the roller by occupying an unnecessarily large volume but also impose an unusually heavy strain on the door mechanism. These difficulties could be partly overcome by having fittings which are merely vertical projections or so shaped that their tops are partly vertical. Even then they would not be entirely satisfactory since the lateral pressure induced would cause the formation of choppy dhool. With a normal-sized fitting, dhool outturn can be forced by the application of heavy pressure but this is also undesirable since "throw-out" will be excessive and circulation of the leaf restricted, which will in turn result in undue development of heat. This naturally must be avoided if quality is not to be lost.

To obtain the maximum efficiency in rolling, therefore, the main requirements are:

1. maintenance of circulation of the leaf under pressure,

2. prevention of crushing of leaf against the jacket,

3. expression of juice by a wringing action and not spoiling appearance,

4. adequate production of dhool,

and 5. minimum amount of "throw-out."

It has now been recognized that the central fittings in use today do not satisfy all these requirements. Either they produce too much of dhool with little twisting action or fail to give the required amount of dhool even under heavy pressure. The necessity for an improved type of central fitting that would prove satisfactory for the whole operation of rolling was therefore evident.

Experiments carried out in the past have clearly demonstrated that the plain cone is the simplest fitting needed to improve efficiency in rolling. The 35° cone developed by the Institute has so far given good results but its use entails, in most cases, the employment of 5 rolls for reducing the bulk. If rolling could be carried out 4 times without adverse effect on the tea, it would mean that one roller less would be required. In present times with the lack of equipment to cope with extra crop a reduction in the number of rolls would certainly be an economic advantage

on most estates. It was mainly with this object in view that an improved type of central fitting was sought which, besides increasing economy, would give the maximum possible efficiency.

In the plain 35° cone the base has to be as large as possible to exercise any effect on circulation. The clearance between the edge of the cone and the jacket at its nearest approach is so small that the only possible method of modification to improve efficiency is to increase the slope of the cone. In doing so, not only does the cone become too bulky but it also exerts a considerable effect on the leaf between the jacket and itself. It would therefore appear that the solution to the problem is to have a cone with the maximum slope permissible which would not smash the leaf and which would, at the same time, be sufficiently large to promote circulation.

The most critical factor in rolling is the distance between the jacket and the centre of the table at their nearest approach. Hence any central device to satisfy the requirements of efficient rolling should bear some relationship to this critical distance, which varies according to the crank throw of the roller and diameter of jacket. This has led to the development of a cone with an angle of 45° at its base and of varying diameter which is now referred to as the Keegel cone to distinguish it from other cones in use. The dimensions of the cone recommended for rollers of different sizes are given in the following table:—

Table 1. *The Keegel cone. Dimensions of 45° cones recommended for full range of rollers in general use.*

Roller	Cone	
	Base	Height
28″ C.C.C.	4″	2″
28″ Walkers	5½″	2¾″
32″ ,,	6½″	3¼″
34″ C.C.C.	7″	3½″
34″ Davidsons	8″	4″
35″ Walkers	8″	4″
36″ Marshalls (and square Jacksons)	9″	4½″
40″ C.C.C.	10″	5″
40″ Walkers	10½″	5¼″
44″ C.C.C. and Davidsons	12″	6″
45″ Walkers	13″	6½″
45.5″ C.C.C.	12″	6″
46.5″ Walkers	11½″	5¾″
46.6″ Davidsons	13″	6½″
47″ C.C.C.	12½″	6¼″

No claim is made that the installation of a Keegel cone would solve all rolling problems, but where results have not been satisfactory due to wrong types and sizes of central fittings some improvement in the teas can be expected by its use. It will for some time to come at least end the confusion which still exists in the choice of cones.

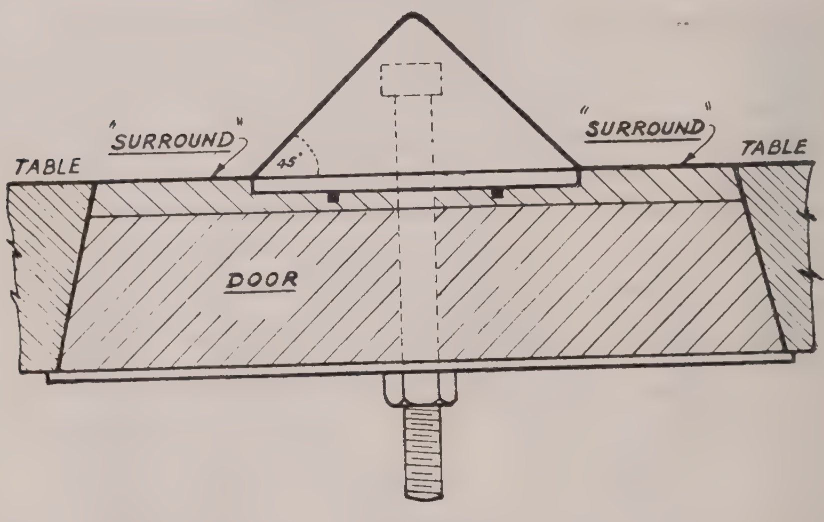
The Keegel cone is recommended for any type of rolling provided pressure is adjusted according to individual requirements. It can be used in conjunction with any type of batten on the market, but in the case of the "M & S" battens certain precautions have to be taken. An annular ring between the edge of the base and the edge of the door should be provided to conform to the shape of the battens

which extend to the edge of the door. The Colombo Commercial Company have now a standard drawing of the manner in which the cone could be adapted to "M & S" battens. In the case of tables having shorter battens such as the "Crescent," all that i required is a flat 'surround,' level with the table.

It is strongly recommended that the cone be installed by an engineering firm, but if it is to be made by a local carpenter the following points should be observed:—

1. The sides of the cone should be straight.
2. The angle at the base of the cone should be exactly 45°.
3. The base should be flush with the table. There should be no projecting edges.
4. The apex of the cone should be slightly rounded off.
5. Pegs should be provided at the base of the cone to prevent it from turning. In the alternative a bolt may be used. (Left-hand thread on bolt for clockwise motion of jacket; right-hand thread for an anti-clockwise motion). The bolt should be at least 1″ in diameter and have a square head.

The accompanying diagram shows the shape of the Keegel cone and the manner in which it should be fixed to the door if it is not cast in brass but made of wood.



— THE KEEGEL CONE —

Drawn by K. Sothisrihari

THE APPEARANCE OF ADULT SHOT-HOLE BORERS *(XYLEBORUS FORNICATUS* EICH) OUTSIDE THEIR GALLERIES UNDER NATURAL CONDITIONS

E. Judenko

The numerous investigations into shot-hole borer hitherto carried out in this country have not considered the behaviour of adult beetles outside their galleries. This is an important observation because a knowledge of the activities of the beetles outside the bush is very essential in the search for practical measures of control to prevent the same beetles attacking the tea bush.

All bark-beetles (*Scolytidae*) approximating the size and appearance of the shot-hole borer of tea collected during the investigation were sent to Professor K. E. Schedl, a Senior Entomologist of the Federal Forestry Research Institute of Austria, for identification. The data presented in this article relate only to the species *Xyleborus fornicatus* Eich, as determined by Professor Schedl.

Appearance of adult beetles outside their galleries on tea bushes

The aims of the experiments carried out on estates in Sabaragamuwa were:

1. to ascertain the influence of rainfall and the age of tea from pruning on the number of beetles which appear on tea bushes,

2. to study the behaviour of the beetles on the lower parts (frame) of the tea bush,

and 3. to determine the proportion of males to females outside their galleries.

Two methods were adopted to obtain this information; the first, by shaking off the beetles from the bush, and the second, by the application of sticky bands around branches.

Experiments with the "Shaking off" method

The method adopted here was to shake off or disturb the beetles from the branches till they dropped into special receptacles made of tin and placed underneath the bushes. The branches were shaken by striking them with a wooden hammer or mallet covered with a pad of cloth to avoid injury to the bush (Fig. 1 in Plate I). The receptacles or containers were of 3 different sizes so that they fitted round bushes of various sizes (Fig. 2 in Plate I). When the "shaking off" was completed the contents of the receptacles were emptied into linen bags which in turn were removed to the laboratory for a careful examination. All bark-beetles (Scolytidae) of the size of adult shot-hole borers of tea were collected and preserved in alcohol.

25 bushes were shaken or disturbed on each occasion. Results of the experiment carried out on one of the estates, *viz.* Denawaka Group, are summarized in table 1.

Table 1. *Denawaka Group, Denawaka Division, Field No. 4, planted in* 1930. *Elevation* 800 *ft.*

Date	Number of adults shaken off			Age of tea from pruning in months	Monthly rainfall in ins.
	Males	Females	Total		
26- 1-56	2	2	4	0	5.84
24- 2-56	0	3	3	1	5.46
23- 3-56	0	1	1	2	12.54
25- 4-56	0	3	3	3	17.78
28- 5-56	0	6	6	4	8.89
28- 6-56	0	1	1	5	21.93
26- 7-56	0	2	2	6	2.17
24- 8-56	0	8	8	7	12.86
29-10-56	0	2	2	9	10.72
17-12-56	0	4	4	11	5.89
25- 2-57	0	2	2	13	9.96
22- 3-57	0	2	2	14	8.57
30- 4-57	0	2	2	15	8.77
22- 5-57	0	3	3	16	11.77
24- 6-57	0	3	3	17	16.44
30- 7-57	0	5	5	18	13.74

Experiments with Sticky Bands

The "bands" consisted of strips of white flexible cardboard $3\frac{1}{2}$ inches wide; they were fastened with the aid of drawing pins round branches of an average girth of $\frac{1}{2}$ inch. This is illustrated in fig. 3 of Plate 2. The bands were greased with the tanglefoot known as 'Ostico' and produced by Messrs. Plant Protection Ltd.

The investigation was carried out at 7 centres. While the experimental bushes on each of the 6 estates carried one sticky band per bush, the 7th experiment on field No. 5 Millawitiya, had 100 sticky bands distributed on 17 bushes. (Fig. 4 of plate 2 illustrates one such bush). The bands were on the average a little over a foot from ground level in the case of the abovementioned 6 estates and $\frac{1}{2}$ ft. in the case of field No. 5, Millawitiya. They were examined at regular intervals when all trapped bark-beetles which resembled shot-hole borer in size and appearance were collected with the aid of needles, cleaned with xylol and preserved in alcohol for future examination. Fresh 'Ostico' was applied to all bands after examination. When any band disappeared it was replaced immediately. Table 2 is typical of the results obtained at one centre in the case of the abovementioned 6 estates, and the record of observations made at Millawitiya Estate field No. 5 are shown in Table 3.

Fig. 1.

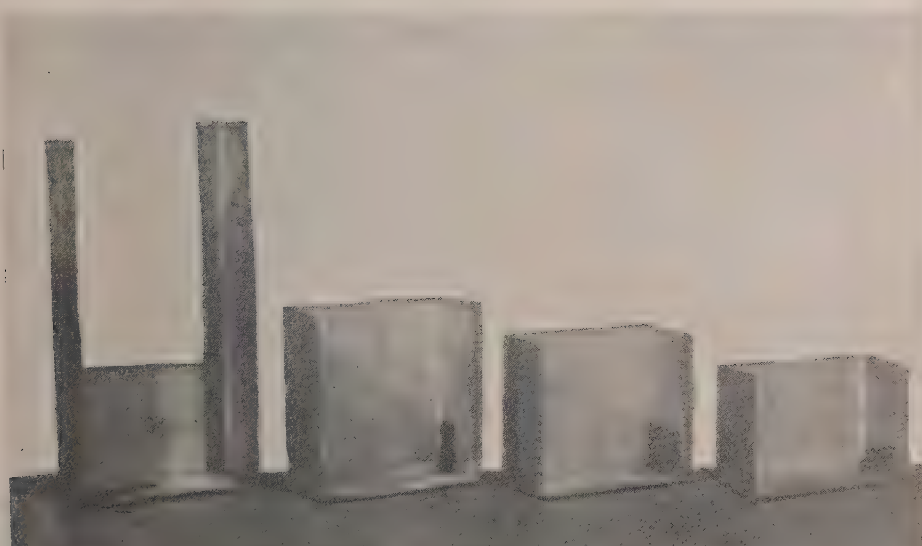


Fig. 2.

Fig 3.

Fig. 4.

Table 2. *Hedgefield Estate. Field No. 5, planted in 1924-1928. Elevation 800 ft. 25 experimental bushes with one sticky band on each of the bushes. Average distance from the surface of the soil to the bases of sticky bands 1 ft. 2ins. (max. 2 ft. min. 2 ins.).*

Period when sticky bands were exposed	Length of period in days	Number of adults trapped			Age of tea from pruning in months	Rainfall in ins.
		Males	Females	Total		
21.2-21.3. 1956	29	0	4	4	20-21	9.39
21.3-20.4	30	0	1	1	21-22	3.48
20.4-21.5	31	0	10	10	22-23	20.16
21.5-25.6	35	0	2	2	23- 0	28.71
25.6-23.7	28	0	1	1	0- 1	1.87
23.7-21.8	29	0	2	2	1- 2	8.48
21.8-27.9	37	0	0	0	2- 3	25.89
27.9-22.10	25	0	2	2	3- 4	18.92
22.10-11.12	50	0	3	3	4- 6	24.63
11-12-56-15.1.57	35	0	2	2	6- 7	4.91
15.1-18.2	34	0	1	1	7- 8	3.39
18.2-18.3	28	0	1	1	8- 9	10.62
18.3-26.4	39	0	2	2	9-10	20.79
26.4-20.5	24	0	1	1	10-11	5.10
20.5-20.6	31	0	5	5	11-12	29.53
20.6-22.7	32	0	2	2	12-13	17.78
22.7-26.8	35	0	1	1	13-14	8.64
26.8-23.9	28	1	0	1	14-15	5.75
23.9-22.10	29	0	1	1	15-16	8.64

Table 3. *Millawitiya Estate. Field No. 5, planted in about 1930. Elevation 300 ft. 100 sticky bands on 17 experimental bushes. Average distance between the soil surface and the bases of the sticky bands 6 ins. (max. 11 ins.; min. 1 inch).*

Period when sticky bands were exposed	Length of period in days	Number of adults trapped			Age of tea from pruning in months	Rainfall during the period in ins.
		Males	Females	Total		
6.10-8.11.56	33	0	1	1	14-15	12.49
8.11-5.12	27	0	2	3	15-16	17.63
5.12.56-7.1.57	33	0	1	1	16-17	4.54
7.1-11.2	35	0	2	2	17-18	6.40
11.2-13.3	30	0	3	3	18-19	9.44
13.3-6.4	24	0	2	2	19-20	4.25

Conclusions

Conclusions drawn from experiments carried out by the "shaking off" method and with "sticky bands," indicate that:

1. there is no correlation between the number of beetles trapped, the amount of rainfall and the age of tea after pruning,
2. female beetles appear more often than males outside galleries,
3. some beetles appear outside their galleries on the lower parts of the bush.

Appearance of Beetles in the Air

The second phase of the investigation consisted of a series of experiments relating to the appearance of beetles in the air. They were designed to ascertain whether the beetles are distributed by air, and if so, the heights and distances they could reach and whether such movements were influenced by rainfall and/or the age of the tea from pruning.

"Sticky traps" as described by Fulton and Chamberlain (1931, p. 758) were used in the investigation. An individual trap consisted of a wooden frame 5′ × 3½′ over which a sheet of galvanized hardware cloth (No. 8) is stretched. Only the cloth is greased, and the sticky surface then measures 4′ 8″ × 3′ 2″. The illustration (fig. 5 in Plate III) shows four such traps placed one on top of the other.

Laboratory experiments had earlier demonstrated that if the mesh of the galvanized hardware cloth was *blocked* with grease, the cloth trapped more beetles than if only the wire was greased. But on the other hand, if all the meshes in the trap were blocked with grease, the air would be obstructed and deflected. Consequently only parts of the cloth, in the shape of squares, were blocked with grease. These squares, eight in number in each frame are seen in figure 5. The rest of the wire mesh was only lightly greased so as to allow currents of air to pass through.

The traps were erected between bamboo poles while the lower trap was supported on two bricks (not visible in fig. 5). To prevent the migration of the beetles from the soil surface the bricks and the bases of the bamboo poles were greased with 'Ostico'. As in the case of the sticky bands 'Ostico' was used for the sticky traps as well. From time to time the traps were cleaned with the aid of xylol and fresh 'Ostico' was applied. The investigation was conducted on 3 estates. Traps were examined at regular intervals when all bark-beetles of the size of *X. fornicatus* were collected, cleaned with xylol and transferred to alcohol for purposes of preservation. A feature of all the collections made was that only female beetles were trapped. This corroborates an observation by Fisher and others (1953, p. 383) that males of the genus *Xyleborus* are incapable of flight

The record of observations made at Millawitiya Estate are shown in table 4.

Table 4. *Record of flight at Millawitiya Estate: Field No.* 6, *planted ab.* 1930 *Elevation* 300 *ft. Height of the bushes just before pruning – ab.* 3 *ft.*

Period	Length of periods in days	Number of females trapped (Figures in brackets refer to the height of the sticky traps above ground level)					Rainfall in inches	Age of tea from pruning in months
		No. 1 (5″-3′ 7″)	No. 2 (3′11″-7′ 1″)	No. 3 (7′ 5″-10′ 7″)	No. 4 (10′ 11″-14′ 1″)	Total		
8.5–22.5.56	15	2	1	1	0	4	5.94	22
22.5–6.6	15	0	0	1	0	1	3.78	22-23
6.6–20.6	14	1	0	1	0	2	13.71	23
20.6–3.7	13	1	1	1	1	4	6.27	23-0
3.7–16.7	13	1	1	6	0	8	1.29	0
16.7–31.7	15	12	3	2	0	17	0.69	0
31.7–14.8	14	0	2	1	1	4	4.37	1
14.8–29.8	15	2	3	1	0	6	7.15	1
29.8–11.9	13	0	1	0	1	2	11.15	1-2
11.9–24.9	13	0	2	0	0	2	3.18	2
24.9–9.10	15	4	1	6	0	11	15.21	2-3
9.10–23.10	14	6	4	1	1	12	5.31	3
23.10–7.11	15	2	1	1	0	4	6.00	3-4
7.11–19.11	12	0	2	0	0	2	8.09	4
19.11–5.12	16	3	0	1	0	4	10.72	4-5
5.12–19.12	14	17	0	0	0	17	1.93	5
19.12.56–2.1.57	14	0	0	0	0	0	2.63	5-6
2.1–15.1	13	0	0	0	0	0	4.14	6
15.1–29.1	14	0	0	0	0	0	0.76	6
29.1–12.2	14	0	0	0	0	0	1.30	6-7
12.2–26.2	14	1	1	0	0	2	7.45	7
26.2–12.3	14	1	7	0	2	10	1.99	7-8
12.3–26.3	14	0	0	0	0	0	2.82	8
26.3–8.4	13	2	2	2	5	11	2.13	8-9
8.4–23.4	15	9	8	5	13	35	7.11	9
23.4–8.5	15	1	1	0	1	3	2.38	9-10
Total	366	65 39%	47 28%	30 18%	25 15%	167		

Fig. 5.

Conclusions.

1. Female beetles are distributed by air at up to about 11-14 feet and this indicates they can reach new clearings from a neighbouring tea field infested with shot-hole borer.

2. The majority of female beetles fly above the level of tea bushes and this demonstrates their ability to reach not only adjoining tea bushes but also bushes placed further away.

3. There does not appear to be any obvious correlation between the number of beetles captured, the amount of rainfall and the age of the tea from pruning.

Acknowledgments

The writer expresses his thanks to Professor K. E. Schedl for the identification of a great variety of beetles without which this report could not have been published; to Superintendents of estates for facilities afforded for the experiments; and to Mr. C. Shanmugam, his assistant, for help in the investigations.

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A NOTE ON THE DISTRIBUTION OF THE ENTRANCES TO THE OPEN GALLERIES MADE BY SHOT-HOLE BORER (*XYLEBORUS FORNICATUS* EICH) ON TEA.

E. Judenko

In a previous paper (Judenko 1958) the writer, in considering the use of contact insecticides against adults of shot-hole borer, described the behaviour of these adults under laboratory conditions, and among other things the heights at which adults appeared on the tea bush. In this note the writer, in considering the same aim, describes the details with regard to the distribution of a number of entrances to the open galleries under field conditions, because the occurrence of these entrances at given heights indicates the presence of the adults at these levels. Only such entrances which appeared above the ground level were investigated.

Young Clearings before Plucking

Examinations were carried out in February, April and November 1957 on 7 clearings on 5 estates, *viz.* Duckwari Group, Hantane, Hapugastenne Group, Mahawale and Wellandura Group. The clearings examined were 12 to 44 months from planting. 118 infested plants of heights varying from 1 ft. 1 in to 4 ft. 7 ins. were examined and of the 274 entrances investigated not one was found higher than $2\frac{1}{2}$ ft. above ground level.

The details are furnished in table 1 below:

Table 1

Height of Tea	Entrances to the open galleries above ground level										Total No. of entrances
	0-6 ins.		7 ins.-1 ft.		1 ft. 1 in.-$1\frac{1}{2}$ ft.		1 ft. 7 ins.-2 ft.		2 ft. 1 in.-$2\frac{1}{2}$ ft.		
	No.	%	No.	%	No.	%	No.	%	No.	%	
1 ft. 1 in. to 2 ft. 3 ins.	40	82	8	16	1	2	0	0	0	0	49
2 ft. 4 ins. to 3 ft. 5 ins.	68	40	59	35	31	18	10	6	2	1	170
$3\frac{1}{2}$ ft. to 4 ft. 7 ins.	13	23.5	9	16.5	19	34.5	7	12.5	7	12.5	55
Grand Total											274

Conclusions

1. The heights at which the entrances to the open galleries were found on young tea plants investigated depended on the heights of these plants.

2. On tea of heights varying from 1 ft. 1 in. to 2 ft. 3 ins. the majority of the entrances were found no higher than 6 ins. above ground level; in the case of tea of heights 2 ft. 4 ins. to 3 ft. 5 ins. no higher than 1 ft. and for bushes of heights of 3½ ft. to 4 ft. 7 ins. no higher than 1½ ft. above ground level.

Tea in Plucking

Examinations were carried out in April and May 1957 on 6 fields of the following estates:—Mahawale, Millawitiya and Pelmadulla Group. These fields were from 4 to 30 years old and from 8-24 months from pruning. 28 infested bushes of height 2 ft. 8 in. to 4 ft. 2 ins. were examined. Of the 488 entrances investigated not one was found higher than 3 ft. above ground level. The details are furnished in table 2.

Table 2

Height of tea	Entrances to the open galleries above ground level												Total No. of entrances
	0-6 ins.		7 ins.-1ft.		1 ft. 1 in.-1½ ft.		1 ft. 7 ins.-2 ft.		2 ft. 1 in.-2½ ft.		2 ft. 7 ins.-3 ft.		
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
2 ft. 8 ins. to 3 ft. 1 in.	61	28	93	42	49	22	15	7	2	1	0	0	220
3 ft. 2 ins. to 3 ft. 7 ins.	34	20	49	29	42	25	31	18	13	7.5	1	0.5	170
3 ft. 8 ins. to 4 ft. 2 ins.	17	17	21	21	29	30	25	26	4	4	2	2	98
Grand Total													488

Conclusions

1. The heights at which the entrances to the open galleries were found on old tea bushes depended on the heights of the bushes.

2. On tea of heights varying from 2 ft. 8 ins. to 3 ft. 1 in. the majority of the entrances were found no higher than 1 ft. above ground level, and on tea of heights 3 ft. 2 ins.-4 ft. 2 ins. no higher than 1½ ft. above ground level.

Summary

1. Considering the heights of individual tea plants, both young and old, it can be concluded that the majority of the shot-hole borer entrances are situated at the lower extremities of the plants.

2. This indicates that the majority of adult beetles appear, at least for some time, on the lower part of the bush.

3. This circumstance, together with the behaviour of the adults observed under laboratory conditions and described in the previous paper, indicate that field trials on the prevention of shot-hole borer attack on tea with contact insecticides are feasible by spraying only the lower parts of the plants.

Acknowledgment

The writer expresses his thanks to Mr. C. Shanmugan, his Assistant, for help in the work.

Reference

Judenko, E. Some observations on the behaviour of the adult shot-hole borer (*Xyleborus fornicatus* Eich) under laboratory conditions. Tea Quarterly, Vol. 29, 1958 pp. 47-50.

PRELIMINARY SMALL-SCALE FIELD EXPERIMENTS ON A CHEMICAL METHOD FOR THE PREVENTION OF SHOT-HOLE BORER *(XYLEBORUS FORNICATUS* EICH.) ATTACK ON TEA IN PLUCKING

E. Judenko

A. Introduction

In the writer's opinion chemical methods for the prevention of shot-hole borer attack on tea in plucking should be investigated from the following aspects:—

I. Entomological aspects, *i.e.* influence of the insecticides on

1. shot-hole borer,
2. parasites and predators of the pest of tea,
3. other pests of tea.

II. Phytotoxity aspect, *i.e.* influence of the insecticides on the plant tissue of tea.

III. Human health aspect, *i.e.* influence of the insecticides on the chemical contents of manufactured tea. (See also Portsmouth 1956 page 95).

IV. Technological aspect, *i.e.* influence of the insecticides on the flavour of tea.

V. Economic aspect, *i.e.* comparison of the costs of treatments with the value of yield increased as a result of the treatment.

All these points are equally important and a chemical for practical routine spraying can only be recommended if all of them were investigated and all the investigations gave satisfactory results.

B. Spraying experiments against shot-hole borer carried out earlier in Ceylon

Considering the abovementioned points, results obtained by Austin (1955 and 1956) and Baptist (1956 a and 1956 b) can be summarized as follows:—

(*a*) **Influence of the insecticides on shot-hole borer.** According to Austin (1956) and Portsmouth (1956) of the many insecticides tested dieldrin has given most promise of effective control. According to Baptist (1956 b) dieldrin is an effective insecticide for the destruction of shot-hole borer.

(*b*) **Influence of the dieldrin on the predators and parasites of pests of tea.**—According to Baptist (1956 a) and Portsmouth (1956) sprayings with dieldrin kill *Macrocentrus homonae* Nixon, the controlling parasite of tea tortrix (*Homona coffearia* Nietn).

(*c*) **Influence of dieldrin on the other pests of tea.**—According to Austin (1955) a serious attack of tea tortrix appeared on the experimental plots of tea treated with dieldrin against shot-hole borer, and also in some of Baptist's (1956 a) experiments with dieldrin and chlordane. According to Baptist (1956 a) dieldrin is more effective against *Macrocentrus homonae* Nixon than against tea tortrix. To avoid destroying the Macrocentrus, Baptist (1956 a) recommended that spraying against shot-hole borer with dieldrin should be carried out 2 to 3 weeks after pruning except in new clearings where the simultaneous application of a special insecticide for tea tortrix control is desirable.

(*d*) **Economic aspect of dieldrin treatment.** This point was investigated only partially *i.e.* by comparison of the yields of treated and untreated plots. According to Austin (1955) in one of the experiments carried at Calbode Estate to determine loss of crop due to shot-hole borer, the total yield obtained from the plots treated with dieldrin was, because of the tortrix attack, lower than from untreated ones. Yield of the experiments commenced by Baptist at Ingiriya Estate were examined by Joachim (1957) and no apparent effect on crop yield of treatment with dieldrin appear; it is possible that this was due to the low infestation of the experimental area with the pest.

The phytotoxity, human health and technological aspects of dieldrin treatments were not investigated. It would appear that of the 7 factors only one, *i.e.* the influence of the chemical on shot-hole borer was investigated and gave positive results. Investigations on the influence of dieldrin on *Macrocentrus homonae* Nixon and tea tortrix gave only partially positive results. Investigations on the economic aspects of dieldrin treatments gave negative results and the 3 remaining factors referred to above were not investigated.

It should be finally mentioned that the Tea Research Institute of Ceylon has on two occasions issued a warning in regard to the use of insecticidal applications for the control of shot-hole borer for the present (see Portsmouth 1956 and report of the Entomologist for the year 1955: Baptist 1956 b).

C. Spraying experiments carried out by the writer

1. **Objects of the experiments.** The objects of the experiments described below are the investigation of the influence of contact insecticides sprayed only on the lower parts of the tea bush, on shot-hole borer and on the plant tissue of tea.

This method of spraying, *i.e.* of the lower parts of tea, is based first of all on the results of investigations with sticky traps (Judenko 1958 c) which showed that a number of adult beetles appear on the lower parts of the tea bush. Then a number of entrances to the galleries made by shot-hole borer were found on the lower parts of the bush (Judenko 1958 d), and finally laboratory observations (Judenko 1958 a) showed that many adult beetles traverse the lower parts of the bush. This type of spraying would largely eliminate the chemical contaminations of the plucking tables of bushes, and at least partially, the destruction of *Macrocentrus homonae* Nixon, the controlling parasite of tea tortrix.

Large volumes of rather high concentrations of insecticides were used in these experiments, and it was planned in case these experiments gave positive results in respect of the destruction of shot-hole borer, to start the next series of experiments using smaller volumes of sprays and in low concentrations.

2. **Insecticides used.** Of those insecticides tested out in the laboratory, *viz.* chlordane, DDT, dieldrin and Lakil, the best results in regard to the destruc-

TABLE 1

Naluwella Group. Ratmalavinna Div. Field No. 2. Age: about 25—30 years. 23 months pruning cycle. Height of bushes at time of treatment: avg. 32", min. 21". max 41" Spraying 8th October, 1957. First rain after spraying: 14th October — 0.05".

Examination No.	Kind of Examination	Control	Chlordane 3.75% sprayed 12" above ground level. 211 gals. p.a.	Dieldrin 0.5% sprayed 12" above ground level. 255 gals. p.a.	Rainfall between day of spraying and day of examination	Age after pruning in months.
		Number of live adults per 50 standard units				
1	Pre-treatment	22	46	47	—	15
2	In 2½ months after treatment	24	1	0	39.05"	17½
	Population as % of that before treatment	109%	2%	0%		
3	In 6 months after treatment	26	1	0	76.54"	21
	Population as % of that before treatment	118%	2%	0%		
4	In 8 months after treatment	40	4	0	96.27"	23
	Population as % of that before treatment	182%	9%	0%		
		Number of live adults per 100 prunings				
5	In 8 months after treatment	403	143	82	96.27"	23
	Population as % of that on control	100%	36%	20%		

TABLE 2

Experiment No.	Estate, division, field age after planting in years	Height of tea in the experimental area at the time of treatment			Post treatment examination No.	Chemicals and amount per acre	Height of spraying above ground level	Date of treatment	Nearest rain		Examination after time of treatment in months	Rainfall between day of treatment and day of examination	Live adults		Age after pruning in months at the time of	
		Avg.	Min.	Max.					Date	Amount			Standard units. Population as % of that before treatment	Prunings. Population as % of that on control	treatment	post treatment examination
I	Rye, div. 2, clear. 1949	15″	14″	18″	1	Chlordane 102 gals.	6″	10.9	10.9	0.30″	12	103.56″	34%	—	1	13
					1	Dieldrin 109 ,,	6″	9.9	9.9	0.14″	12	103.70″	12%	—	1	13
					1	Control	Nil	Nil	—	—	12	—	168%	—	1	13
II	Rye, div. 2, field 13, ab. 35 years	31″	24″	41″	1	Chlordane 250 gals.	12″	13.9	28.9	0.08″	7	75.34″	7%	—	14	21
					1	Dieldrin 229 ,,	12″	13.9	28.9	0.08″	7	75.34″	0%	—	14	21
					1	Control	Nil	Nil	—	—	7	—	61%	—	14	21
					2 & 3	Chlordane 250 gals.	12″	13.9	28.9	0.08″	12	103.26″	43%	74%	14	26
					2 & 3	Dieldrin 229 ,,	12″	13.9	28.9	0.08″	12	103.26″	63%	52%	14	26
					2 & 3	Control	Nil	Nil	—	—	12	—	164%	100%	14	26
III	Naluwella Gr., Ratmalavinna div., field 2, ab. 25-30 years	32″	21″	41″	1	Chlordane 211 gals.	12″	8.10	14.10	0.05″	2½	39.10″	2%	—	15	17½
					1	Dieldrin 255 ,,	12″	8.10	14.10	0.05″	2½	39.10″	0%	—	15	17½
					1	Control	Nil	Nil	—	—	2½	—	109%	—	15	17½
					2	Chlordane 211 gals.	12″	8.10	14.10	0.05″	6	76.54″	2%	—	15	21
					2	Dieldrin 225 ,,	12″	8.10	14.10	0.05″	6	76.54″	0%	—	15	21
					2	Control	Nil	Nil	—	—	6	—	118%	—	15	21
					3 & 4	Chlordane 211 gals.	12″	8.10	14.10	0.05″	8	96.27″	9%	36%	15	23
					3 & 4	Dieldrin 255 ,,	12″	8.10	14.10	0.05″	8	96.27″	0%	20%	15	23
					3 & 4	Control	Nil	Nil	—	—	8	—	182%	100%	15	23
IV	Pettiagalla, Upper div., field 2B., ab. 40 years	39″	31″	49″	1	Chlordane 258 gals.	12″	9.10	12.10	0.20″	2½	43.77″	43%	—	20	22½
					1	Dieldrin 273 ,,	12″	9.10	12.10	0.20″	2½	43.77″	7%	—	20	22½
					1	Control	Nil	Nil	—	—	2½	—	161%	—	20	22½
					2	Chlordane 258 gals.	12″	9.10	12.10	0.20″	6	82.38″	23%	—	20	26
					2	Dieldrin 273 ,,	12″	9.10	12.10	0.20″	6	82.38″	2%	—	20	26
					2	Control	Nil	Nil	—	—	6	—	100%	—	20	26
					3 & 4	Chlordane 258 gals.	12″	9.10	12.10	0.20″	12	127.46″	9%	71%	20	32
					3 & 4	Dieldrin 273 ,,	12″	9.10	12.10	0.20″	12	127.46″	4%	58%	20	32
					3 & 4	Control	Nil	Nil	—	—	12	—	48%	100%	20	32
V	Upper Balangoda, Buluhalanda field, ab. 34 years.	34″	26″	46″	1	Dieldrin 232 gals.	12″	10.10	12.10	0.09″	3	48.67″	2%	—	18	21
					1	Dieldrin 117 ,,	6″	10.10	12.10	0.09″	3	48.67″	3%	—	18	21
					1	Control	Nil	Nil	—	—	3	—	47%	—	18	21
					2	Dieldrin 232 gals.	12″	10.10	12.10	0.09″	9	97.12″	—	24%	18	27
					2	Dieldrin 117 ,,	6″	10.10	12.10	0.09″	9	97.12″	—	23%	18	27
					2	Control	Nil	Nil	—	—	9	—	—	100%	18	27

Showing method of spraying & protective clothings worn.

tion of adult beetles and the phytotoxity effect were obtained from chlordane and dieldrin. These insecticides were therefore used in the field experiments described below.

Chlordane was used in the form of a miscible oil formulation at a strength of 3.75% of the technical chlordane and dieldrine was used as 0.5% spray in the form of emulsion.

3. **Lay out of the experiments, equipment and the technique of spraying.** There were 5 plots for each treatment and control, *i.e.* 15 plots in each of the 5 experiments (see table 2) and the number of bushes in plucking per plot in case of experiment No. 1 was 32, and in the remaining experiments, 24. Two rows of bushes were left as buffer between individual plots. To prevent the migration of the beetles from the buffer rows to the plots along the adjacent branches, those on the boundaries were periodically cut.

The following durations of pruning cycle were adopted in the experimental areas:—experiments Nos. I, II and IV, 36 months, experiment No. III, 23 months and experiment No. V, 27 months.

The heights of 5 bushes on each of the plots were measured, and on the basis of these 75 measurements, data regarding the heights of the bushes (table 2) in the individual experiments were obtained.

Spraying was done with Birchmeier "Automat" self-acting knapsack sprayers with incorporated pressure pump. The liquid capacity of this sprayer is about 2¼ imperial gallons. The sprayers were fitted with single "Duro" nozzle with removable steel disc 1.65 mm. The individual bushes were sprayed first around the bushes from outside at heights of 6″ or 12″ above ground level, and afterwards the spraying lance was put inside the lower parts of the bushes at a height of 6″ or 12″ and again, only these parts were sprayed. Not only were the lower parts of tea copiously sprayed, but also some part of the soil surface adjacent to the tea bushes. In each experiment spraying was carried out once only in September and October, 1957.

The volumes of insecticides used were calculated on the basis of 2,500 bushes in plucking per acre (Tables 1 and 2).

4. **Weather conditions during the sprayings.** Rain started during both sprayings of experiment No. I and it also rained on the same days after the sprayings were completed. In the four remaining experiments, there was sunny weather during sprayings and the bushes were dry. In these experiments rain fell 2, 3, 6 and 15 days after spraying.

5. **Precautionary measures.** (a) Measures for the protection of operators handling insecticides and of supervisors. In accordance with the recommendations of the Study Group on the toxic hazards of pesticides to man (1956) precautionary measures were taken to protect operators handling insecticides and also supervisors. On the advice of the late Dr. F. Gunaratna, a member of the abovementioned Study Group, operators and supervisors used aprons which covered the front and rear portions of the body, and long trousers (see plate I). This clothing was washed once weekly. The operators and supervisors also wore shoes. The operator handling the concentrates used rubber gloves while working (see plate II). After the spraying was over,

the operators and supervisors thoroughly washed the uncovered parts of their bodies with soap and water.

(*b*) Preventions against contamination of drinking water. All operations connected with the handling of concentrates, preparation of solutions, and washing of spraying equipment were done over specially dug trenches (see plate II) far away from any source of water. No experimental plots were sited near streams.

(*c*) Measures for the protection of the plucking table of tea. The sprayings were done by two laboratory attendants. One of them was supervised by the writer and the other by his assistant. As was mentioned above, only such parts of the tea bush which were lower than 6″ or 12″ above ground level were sprayed and no droplets were seen to fall on the plucking table.

While the operators were moving between the rows of tea, the spraying lances were kept as low as possible, certainly much lower than the level of the plucking table.

6. **Examination of the Results of Experiments**. The number of live adults inside the given number of standard units (Judenko 1958 b) was considered as a criterion for the investigation of the influence of the chemicals on shot-hole borer. 15 standard units were collected from each of the plots in experiments Nos. I and II, and 10 in the remaining 3 experiments. If the number of live adults in the control plots in any of the post-treatment examinations was less than 45 per cent of that before treatment, such examinations were not considered and not shown in the table. This was one of the reasons why some examinations of experiment No. I (and also of some other experiments) were not considered.

There were also dissected 20 prunings in some of the post-treatment examinations collected from each plot (*i.e.* 100 prunings for each treatment and control) in the case of experiments Nos. II, III and V, and 40 prunings from each plot (*i.e.*200 prunings per each treatment and control in case of experiment No. IV.

Details regarding experiment No. III are furnished as an example in table 1 and a summary of all the experiments given in table 2.

Examinations regarding the phytotoxity effect were carried out a few days after the treatments and later, and no injury to the tea bushes as a result of spraying was observed.

7. **Conclusions**.

1. Only two examinations were done in the case of experiment No. I, and they do not permit any firm conclusions being drawn. However, these two examinations carried out 12 months after spraying indicate that some reduction in the number of live adults does take place when tea of the average height of 15″ at 1 month after pruning is sprayed once to a height of 6″ above ground level.

2. Four examinations carried out in experiment No. V, where the average height of bushes was 34″ show, that there were no significant differences in the degree of reduction of numbers of live adults between the plots sprayed once at heights of 6″ and 12″ above ground level, 3 and 9 months after treatment.

3. 18 examinations of the experiments Nos. II-V, where the average height of bushes was 34″, show that single sprayings at heights of 6″ and 12″ above ground level carried out 14, 15, 18 and 20 months after pruning caused a considerable reduction in the number of live adults 2½ to 9 months after treatment.

4. 8 examinations of the experiments Nos. II and IV, where average heights of bushes was 35″ would indicate that single sprayings of tea at a height of 12″ above ground level carried 14 and 20 months after pruning still caused some reduction in number of adults 12 months after treatment.

8. **Further experiments.** After the data from the first examinations of experiments Nos. III, IV and V were obtained a second series of experiments were started where spraying with single treatments of the lower parts of the bushes was done, the spray liquid being used at an average rate of approximately 110 gls. per acre.

There are investigated in these experiments dosages of insecticides, which approximate the average cost, in the case of both chlordane and dieldrin, of Rs. 10, Rs. 50, and Rs. 100 per acre.

9. **Summary.**

1. In these experiments chlordane of a strength of 3.75 per cent of the technical chlordane as the active ingredient and dieldrin of a strength of 0.5 per cent of active ingredient was used.

2. When tea was sprayed at a height of 6″ above ground level, the spray liquid was used at an average volume of approximately 110 gals. per acre and when sprayings were done at the height of 1 ft. above ground level the corresponding volume was 245 gals.

3. Experiments with tea at the average approximate height of 3 ft. show there were no significant differences in the degree of reduction of numbers of live adults between the plots sprayed once at heights 6″ and 1 ft. above ground level.

4. When tea of the average approximate height of 3 ft. at 14, 15, 18 and 20 months after pruning, was sprayed once at heights of 6″ and 1 ft. above ground level, there was a considerable reduction in the number of live adults 2½, 3, 6, 7, 8 and 9 months after treatments.

5. No injury was caused to the tea by the spraying.

6. Owing to the favourable results obtained from these trials, a new series of experiments were started where single spray treatments of the insecticides were given in lower volumes and at lower concentrations to the lower parts of the bush.

7. No practical recommendations emerge from the experiments described.

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ACARICIDAL TRIALS AGAINST THE SCARLET MITE, *BREVIPALPUS AUSTRALIS* TUCKER, ON TEA

D. J. W. Ranaweera.

Introduction

Scarlet mite, originally known as *Brevipalpus obovatus* Donn., was first observed on tea by Green in 1890 but it was only sixty years later that it reached the status of a pest. Prior to 1950 the mite invariably manifested itself only during periods of dry weather, but subsequently it was observed during the rains. Defoliation which is most noticeable in the third year of pruning is a characteristic feature of recent severe outbreaks. The lighter type of pruning adopted in recent years, which obviously could not have affected a total elimination of the mites at pruning, is a probable contributory factor to the carry over of the pest from one cycle to another.

Dusting with sulphur was the only specific acaricide which was recommended for its control in earlier years, the reason being that no estate possessed any spraying equipment. With the arrival of blister blight the situation changed. Most up-country tea estates are now equipped with batteries of sprayers, and these are, therefore, available for checking an outbreak of mites by spraying with acaricides, which is far more effective than dusting.

Acaricidal applications

(*a*) **Tainting acaricides** :—Although sulphur is one of the cheapest and most effective acaricides in the market, a great disadvantage in its application on tea is the undesirable taint it causes to the manufactured product. It has been found that if sulphur is applied to tea in plucking for the control of mites, a period of three weeks after the last application must elapse before the leaf from the treated tea could be used for manufacture, to avoid taint.

The most suitable time for the applications of sulphur for scarlet mite control is, therefore, between pruning and tipping when three to four applications, at intervals of a week to ten days, could be made. An interval of three weeks is necessary between the last application of sulphur and the first plucking.

As scarlet mites live on the under side of the more mature leaves, spray applications for their control should be directed to reach the under side of such leaves. During the period following pruning, when there are only a few branches and leaves left on the bushes, the labourers could carry out the spraying operations efficiently.

When a scarlet mite infested field is pruned a large proportion of the mite population is eliminated in the prunings. As the leaves on the prunings dry up, the mites on the infested leaves die. A few mites, however, migrate back to the bushes and continue to live on the few leaves and green portions of the side branches that are left on the frames. It is at this period that a thorough application of the acaricide is necessary, either as a spray or dust. This operation or measure should reduce the residual mites to an extremely low level and avoid a build-up in the 3rd or 4th year, provided of course no serious re-infestation occurs from outside sources such as shade trees.

(*b*) **Non-tainting acaricides.**—Chlorobenzilate (Akar), an organic compound, is one of the non-tainting and effective acaricides against scarlet mites that has come

into use recently. One week should, however, elapse between its application and the following pluck. The cost of Akar is about three times that of wettable sulphur. The product is compatible with the copper fungicides usually used in blister blight control and could be incorporated with such fungicides without harmful effects to the tea.

Planting Opinion.—In planting circles opinion prevails that when a scarlet mite field is pruned and most of the mite infested leaves are removed, the mites which are left behind on the leaves and those that fall from the shade trees may be effectively controlled if Akar is introduced in correct proportions into the routine spray recommended for the control of blister blight. If this method is adopted from the commencement of blister control and continued throughout the cycle, it is assumed that a build-up of scarlet mites in the third and fourth years may be prevented.

It is obvious that if combined applications of acaricides and fungicides are effective against both scarlet mites and blister blight, a considerable saving could be effected by reducing the cost of special spray operations for mite control work.

Another advantage of this combined method is the elimination of the difficulty of maintaining a separate set of spraying machines for sulphur applications and another for copper spraying during the blister season. If the machines used for the applications of sulphur are also used for copper spraying, there is always the risk of sulphur taints developing in the made tea.

Earlier Trials.—Baptist and Ranaweera (1955) have indicated that weekly applications of a light spray of Akar in the dilution of 1 in 1,000, applied from above as for blister blight control at 15 gallons of spray per acre, do not give adequate control compared with heavy applications of the same acaricide (150 gallons per acre) of the same concentration directed to reach the under sides of the foliage where the scarlet mite lives and breeds. Their experiment was limited to 4 applications of both treatments when their report was written. Table I gives the comparative figures of control achieved for the same experiment, continued over a period of 14 weeks. Fourteen light sprays of Akar in the dilution of 1 in 1,000 were given against 8 heavy applications, the latter number being restricted by the absence of mites in these plots after this particular application. But it will be noticed that at the end of the 14th weekly light application an appreciable number of mites continued to survive.

Table I. *Chlorobenzilate (Akar) applied in light and heavy sprays.*

Time of Estimation	Light Spray		Heavy Spray		Control	
	No. of live mites present	Percentage	No. of live mites present	Percentage	No. of live mites present	Percentage
Before application	257	100	165	100	210	100
5 days after 1st application	191	74	73	44	193	92
6 –do– 2nd –do–	160	62	29	18	224	107
6 –do– 3rd –do–	106	41	6	4	180	86
6 –do– 4th –do–	95	37	1	1	201	95
8 –do– 5th –do–	88	34	3	2	190	90
7 –do– 6th –do–	93	36	—	—	166	79
8 –do– 7th –do–	101	39	3	2	145	69
6 –do– 8th –do–	80	31	—	—	135	64
8 –do– 9th –do–	72	28	—	—	120	57
7 –do– 10th –do–	57	22	—	—	138	66
6 –do– 11th –do–	77	30	—	—	131	62
7 –do– 12th –do–	96	37	—	—	168	80
7 –do– 13th –do	77	30	—	—	177	84
8 –do– 14th –do–	72	28	—	—	121	58

Recent Trials.—In order to determine the relative effectiveness of sulphur (Spersul) when applied as a heavy post pruning spray, compared with a light spray application of Chlorobenzilate (Akar) incorporated with Perenox in the routine blister control spray, a replicated trial was started on a field of tea at St. Coombs estate at the beginning of the cycle soon after pruning. The field had run for 4 years and had a fairly heavy attack of scarlet mite.

Treatments which were randomised and replicated six times in six blocks were as follows:—

1. Sulphur applied as Spersul, at a concentration of 1 lb. in 25 gallons of water and at the rate of 40 gallons to the acre, as a special spray in 4 applications at two-weekly intervals; first application 4 weeks after pruning. Old leaves left behind on the branches at the time of pruning were removed between the 3rd and 4th application as recommended by Baptist and Ranaweera (1955).

2. Chlorobenzilate (Akar) incorporated with Perenox at a concentration of 1 in 1,000 by volume, applied at the rate of 15 gallons to the acre as a light superficial application in the normal blister control spray, commencing 4 weeks after pruning and continuing throughout the cycle.

3. Untreated.

Records.—Mite counts were carried out at monthly intervals. Dry weights of weekly pluckings were kept in order to ascertain any possible loss of crop.

After the 53rd application, the incorporation of Akar in the Perenox spray was discontinued and all plots given normal blister protection by spraying them with Perenox alone once a week. Table II below gives the records of mite counts and dry weight yields.

Table II. *Chlorobenzilate (Akar) light spray incorporated with Perenox* versus *Sulphur (Spersul) heavy spray.*

Treatments

Month	Spersul heavy spray				Akar and Perenox light spray				Untreated			
	Total No. of sprayings given	Mite counts at the particular month	Total mite counts	Total dry wgt. yield (pounds)	Total No. of sprayings given	Mite counts at the particular month	Total mite counts	Total dry wgt. yield (pounds)	Total No. of sprayings given	Mite counts at the particular month	Total mite counts	Total dry wgt. yield (pounds)
[illegible]th	4	11	15	25.98	18	154	204	25.44	Nil	183	304	27.82
[illegible]th	4	540	3,749	208.74	53	429	5,589	212.34	Nil	629	9,512	216.13
[illegible]th	4	1,770	9,301	327.70	53	1,904	11,395	335.52	Nil	2,643	16,340	335.77

Comparative costs of 2 treatments:

Heavy application of Spersul.—Cost of spraying 1 acre of pruned tea with Spersul at a concentration of 1 lb. in 25 gallons water and at the rate of 40 gallons to the acre per round for 4 rounds.

Cost of Spersul @ 85 cts. per lb.		Rs.	5.44
,, ,, labour 1.5 labourers per acre per round × 4 rounds		,,	15.00
		Rs.	20.44

Light superficial application of Akar.—Cost of spraying 1 acre of tea recovering from pruning with Akar (incorporated with a copper fungicide) at a concentration of 1:1,000 and at the rate of 15 gallons to the acre for 53 rounds.

Cost of Akar	@ Rs. 100/- per gallon	Rs.	79.50
Cost of labour			Nil
		Rs.	79.50

Yield.—No significant difference in yield was noticeable in the three treatments up to 20 months from pruning.

Bush Defoliation.—A general defoliation due to mite attack was not observed in the untreated plots up to the 20th month from pruning.

Discussion

An examination cf the date of Table 2 would indicate that the post pruning heavy spray treatment of Spersul coupled with the removal of old leaves after the third application was more effective in reducing the mite population up to the 6th month from pruning than the Akar and Perenox light spray treatment. Thereafter, there was a build-up of mite populations in all treatments, so that at the 15th month from pruning the mite population was about the same in both the treated plots and in the control. There was no difference in yield between the treated plots up to the 20th month from pruning, nor was any general defoliation observed in the bushes up to that period.

Since the sulphur treatment was much the cheaper of the two, it would appear that the opinion held in planting circles, that the incorporation of a non-tainting acaricide like Akar with the weekly applications of fungicide sprays for the control of blister blight was the most economical measure of control for scarlet mite, was not borne out by these trials.

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*SOME NOTES ON SCARLET MITES AND LONGER PRUNING CYCLES

P. R. U. Easteal

(Gouravilla, Upcot)

There seems little doubt that the incidence of Scarlet Mite continues to increase, because of our lack of basic knowledge on their biology and ecology. We do not know, for instance, why the increase in mite populations has occurred in the past six years or so, neither do we know definitely how re-infestation occurs after pruning.

The lighter pruning some estates have adopted in recent years obviously leaves a larger residual infection at the time of pruning, while longer pruning cycles provide the extra time for a build-up to take place. Many estates, however, still carry out a 'clean' prune and despite this, they find that large 'build-ups' of populations do occur.

Observations in the field have shown that there are no mites on frames of pruned tea and, while most weeds with the exception of ferns have been found with mites on them, those mites have been very few in number and certainly not a potential source of heavy re-infestation. Recently many samples of soil, mulch and prunings from a recently-pruned field have been examined but no scarlet mites were found. Given a clean prune, therefore, whence comes this re-infestation ? With our present state of knowledge the most likely answer would appear to be 'from the shade trees.'

Attacks are now so severe as to limit crop production in nearly all fields up-country on anything over a four year cycle; appreciable defoliation can be seen in fields only three years from pruning. If a field is to run for more than four years, therefore, it would seem advisable to give it some form of acaricidal treatment during its third year.

The aim of all endeavours must be to reduce the mite populations to such low numbers that a build-up of economic proportions between prunes is unlikely. This may not prove possible to achieve, but if an attempt is to be made then some steps will have to be taken against the mites living in shade trees.

Mites cannot fly, neither can they live for very long without food. The rough bark of a mature shade tree offers them no source of food and it is extremely doubtful whether they could survive long enough to climb to the top of, say, a mature tree of *Grevillea robusta* or *Albizzia moluccana*, the two species which carry by far the largest populations. The writer has examined the bark of many shade trees immediately after pruning and has not found any mites on the bark of a mature tree, and only an occasional one on young trees; there have certainly not been the positive streams

* *The Institute does not necessarily endorse the views expressed in papers contributed by persons other than members of the staff.*

which could be expected if there were a general migration from pruned tea to shade trees, as has been suggested. The answer to the question of how the mites get into the shade trees can be found, I think, if very young grevilleas are examined. Most of these will be found to carry quite large populations and it seems evident that the initial infection occurs as the young trees grow up through the tea.

If this is correct, and there is no other source of infection, it would appear that it is only necessary to pollard shade trees, removing *all* leaves and with them *all* mites to eliminate any chances of re-infestation. As a few mites have been seen on the bark of young shade, it would be necessary to take other measures with regard to these.

Pollarding shade at pruning time would leave the field denuded of shade when it is most required, but pollarding during its third year would not have this disadvantage, as the soil would then have a cover of tea.

The life cycle of the scarlet mite is comparatively long and the build-up of populations correspondingly slow, but nevertheless it should be apparent that to be effective acaricidal measures should provide a 'kill' of over 90 per cent, otherwise there is the time, and there are the mites available to produce a heavy re-infestation before pruning.

Of the various acaricides tried so far sulphur is the most efficient we can use on tea, but it has the great disadvantage of giving a taint to the made teas; because of this tainting any tea in plucking must be rested for three weeks after the last sulphur application. Given three weekly applications of sulphur, therefore, tea will be out of plucking for six weeks.

Comparative trials between dusting and spraying have so far indicated that spraying with high volume nozzles gives better results than does dusting, but the difficulties of obtaining a good coverage in a three-year old field are obvious. If the field is skiffed across, however, the foliage is considerably reduced and a satisfactory coverage more easy to obtain.

Skiffed tea takes about six to seven weeks to come into plucking but as the tea sprayed with sulphur is out of plucking anyhow, no extra crop will be lost. There is indeed a good chance that no crop will be lost at all as:

1. A very good plucking table will be re-introduced.

2. A mild rush of crop can be expected when the bushes come back into plucking.

3. The operation can be timed so that some of the tea is out of plucking during the normal rush period, thus helping to 'even out' crop. Indeed the best time to spray sulphur is obviously during dry weather and just before rain is expected.

4. The control of mites should greatly benefit both the tea bush and the field crop figures for the remainder of the cycle.

To sum up then, it would appear that if an up-country field carries a large population of scarlet mites and is due to be pruned on a cycle longer than four years, the following treatment might warrant consideration:—

1. Skiff the field at the end of the usual dry period during its third year.

2. Pollard shade trees, more especially *Grevillea robusta* and *Albizzia moluccana.*

3. Spray with sulphur for three weekly rounds using lime-wash nozzles and applying at the rate of at least 4 lbs. in 100 gallons to the acre. Spray the bark of young shade trees, and, in the case of very young shade, as much of the foliage as can be reached.

A very careful watch must be kept for blister blight after skiffing as it is very easy for an attack to develop unnoticed on the new flush forming below the skiffed level. It is advisable to dust at least one round with copper immediately after the third sulphur application, even though the weather be dry.

After any skiff, extra care must be taken to remove all 'banjies' when bringing the field back into plucking.

It is the writer's experience that costs work out as follows:—

Skiffing @ 7 labourers per acre	...	Rs.	17.15
Spraying 3 rounds at 6 labourers per acre	...	,,	14.70
Sulphur 3 rounds @ 4 lbs. per round	...	,,	7.68
Total	...	Rs.	39.53

Cost of pollarding will depend on the stand of shade, and extra expense will be incurred in bringing the field back into full plucking.

MISCELLANEOUS NOTES

*SOME OBSERVATIONS ON THE USE OF MAGNESIUM SULPHATE FOR A CHLOROSIS OF TEA

D. Roe
(Ferham Estate, Talawakelle)

Experiments started some 5 years ago at Ferham Estate when a small area of tea which had magnesium sulphate (Epsom salts) applied to the soil at as high a rate as 4 oz. per bush in an attempt to cure rather acute 'yellowing' (chlorosis) showed no improvement of any sort. Spraying with the salt was therefore tried out. Results were noticeable in a matter of weeks and the area under test was increased until finally the whole estate was done. At the end of a year the following results were observed:

(*a*) Plucking dieback was almost entirely eliminated.
(*b*) Hollows in plucking table were filled—a quicker breakaway.
(*c*) A 30 to 50 lb. per acre crop increase.
(*d*) Considerable improvement in the incidence of yellow mite.
(*e*) Much improved infusions during period of spraying for blister with copper fungicide.
(*f*) Definite decrease in yellowing.

It is appreciated that the above list reads as if magnesium sulphate is the elixir of life for the tea bush. It is, however, possible to substantiate, at least partially, items 'd' and 'e'. For the rest individual estates will have to try it out for themselves.

Taking 'd' first the following is an extract from the V.A's Report:—"Certainly the preliminary spraying in No. 4 has improved matters compared with an untreated area."

As regards 'e' two lots of leaf from the same field, during the monsoon, were plucked and manufactured on the same day. Sample 'A' had been sprayed with fungicide and magnesium sulphate and sample 'B' with fungicide only. The samples were sent to Colombo for examination. The following is an extract from the Brokers' report:—

> "The improved colour of the infused leaf of the treated tea (A) is quite remarkable in view of the fact that the difference in cup quality was not nearly so pronounced."

Epsom salts at the rate of $1\frac{1}{2}$ lb. per acre was mixed with the blister fungicide at approximately 6 oz. per acre and the mixture, dissolved in 15 gallons of water, sprayed as usual. The admixture appeared to have no adverse effect on the control of blister blight, and there was no taint apparent. Costs over the year (36 applications) approximated $1\frac{1}{4}$ cents per lb. of made tea on a yield of 900 lb. when applied with the fungicide or $4\frac{1}{2}$ cents per lb. if sprayed separately. It is considered that with further experiment, this quantity (*i.e.* $1\frac{1}{2}$ lb.) could be reduced appreciably.

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REVIEW

TEA

by

Dr. T. Eden

(Longmans, Green & Co., Price £ 1-15-0)

Dr. Eden's name has been a byword in the tea world for the past 30 years during which he has been engaged on carrying out or directing research on the crop in widely-differing areas of the tropics where tea is cultivated. There are, therefore, few, if any, better qualified than he to undertake the writing of an authoritative work on the science and practice of tea cultivation and manufacture.

In his recent book Dr. Eden has furnished in his clear, characteristic style with comprehensiveness and yet withal accuracy, much of the information available on the results of research on the tea crop.

Set with the choice of three alternative methods of treatment of his subject, he rightly decides "to give a descriptive account of the various stages of tea cultivation and manufacture on which to base a discussion of the principles involved." In this task he has been eminently successful.

There are some who may disagree with certain of his views, but he makes no excuse for giving interpretations to conclusions drawn from research on the crop that are coloured by his own experience, as, in his opinion, "the dullest of all books is that which conceals the viewpoint of the author." But no one can lightly dismiss these views of a scientist of mature judgment, born of years of experience, close observation, and, in several instances, careful experiment.

The book covers all aspects of the subject and comprises 15 chapters dealing with such matters as planting material, pruning and plucking, manuring, diseases and pests and their control, the chemistry of the tea leaf and of its manufacture, tea manufacture and tasting, and the tea trade and statistics. It is well illustrated, contains numerous citations of the relevant literature, and has a carefully prepared index. Accordingly, the book will be a valuable guide to anyone connected with tea interests, but primarily will it be useful to all those who are actually engaged in the cultivation and manufacture of the crop or to those concerned with its scientific study.

Though the book is up-to-date to the time of writing, there are developments that have since taken place in respect of certain agronomic or manufacturing practices, *e.g.* the bringing of young tea into bearing by such methods as bending, layering and thumb-nailing, side or reverse rim-lung pruning, and the preparation of instant tea from green leaf. All these will no doubt find a place in a second edition of the book which, with the demand it should have among a wide circle of readers, would be needed in a comparatively short time.

It is not given to many to review the publications of an erstwhile colleague in such widely-different fields of agriculture as tea cultivation and tropical soils within the comparatively short space of a decade, but this is the reviewer's privilege and pleasure.

A.W.R.J

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT ST. COOMBS TALAWAKELLE, AT 9.30 A.M. on FRIDAY, 7th MARCH, 1958.

Present.—Mr. F. Amarasuriya (Chairman), Dr. M. F. Chandraratna, M.B.E. (Director of Agriculture), Messrs. B. Mahadeva (Tea Controller), R. M. Macintyre (Chairman, Agency Section, Planters' Association of Ceylon), R. C. Scott, C.B.E., W. H. W. Coultas, N. M. Sanders, R. J. Gilmour, R. D. Wedd, J. L. D. Peiris, E. Jayawickreme, V. G. W. Ratnayaka, M.B.E., A. G. Divitotawela, Dr. A. W. R. Joachim, O.B.E., (Acting Director) and Mr. G. A. D. Kehl (Secretary).

Letters regretting their inability to attend were tabled from Senators E. W. Kannangara, C.B.E., T. Amarasuriya, O.B.E., and Messrs. G. K. Newton and H. E. Peries, O.B.E.

1. Notice convening the meeting was read.

2. **Minutes of the Meeting of the Board held on 10th January, 1958**

The minutes of the meeting of the Board held on 10th January, 1958, were confirmed subject to corrections notified to members in Circular A.13/58 of 1st March, 1958.

3. **Matters Arising out of the Minutes**

Page 5. Item 9(ii)—Research Assistants.—The Acting Director gave details of the action he proposed to take regarding the overseas training of the Research Assistants in the Pathology and Entomology Departments. This was approved.

4. **Membership of the Board and Committees**

(i) **Board.**

The following changes were reported:—

EX-OFFICIO

Mr. R. M. Macintyre on his election as Chairman of the Agency Section of the Planters' Association of Ceylon became an Ex-Officio member of the Board as from 20th February, 1958.

REPRESENTING THE PLANTERS' ASSOCIATION OF CEYLON

Mr. W. H. W. Coultas resumed his seat on the Board on his return from leave with effect from 22nd February, 1958.

Mr. N. B. Parker resigned his seat with effect from 22nd February, 1958.

Mr. N. M. Sanders had been nominated to fill the vacancy created by Mr. Parker's resignation with effect from 22nd February, 1958.

Representing the Agency Section of the Planters' Association of Ceylon

Mr. R. J. Gilmour had been nominated in place of Mr. R. M. Macintrye with effect from 24th February, 1958.

Mr. G. K. Newton had resumed his seat on his return from leave. He had since been renominated to serve a further period of 3 years from 24th March, 1958.

(ii) **Committees.**

Finance Committee

Mr. R. J. Gilmour was appointed to fill the vacancy in the Finance Committee.

Standing Committee and Building Committee

Mr. W. H. W. Coultas had resumed his place on the above Committees relieving Mr. N. M. Sanders as from 22nd February, 1958.

Trustees of the T.R.I. Junior Staff Provident Fund

Mr. R. J. Gilmour was appointed to take the place of Mr. A. D. McLeod.

The Chairman thanked the outgoing members and welcomed the new members and those back from leave.

5. Minutes of the Experimental and Estate Committee Meeting held on 8th February, 1958

Page 1. Item 3(i)—Manureapplication.

In reply to Mr. V. G. W. Ratnayaka the Acting Director outlined the policy of the Institute regarding forking in relation to manuring.

Page 2. Item 4 (ii)—Biochemistry.

Mr. Coultas urged the Board to take early action in furthering the development of 'soluble' or 'instant' tea as he felt that the Ceylon tea industry was not keeping pace with modern developments and suggested that a specialist on this line of work might be recruited.

The Board agreed with Mr. Coultas that this matter should be pursued, but before making any definite decision it requested the Acting Director and the Technologist to consult the Ministry of Commerce and Trade, the Ceylon Institute of Scientific and Industrial Research, and the Ceylon Tea Propaganda Board on the subject and to submit a comprehensive report for its consideration at its next meeting.

Page 3. Item 4 (vii)—Pathology.

To a question from Mr. N. M. Sanders concerning the appointment of a specialist for the study of eelworms, the Acting Director said that this matter had received the consideration of the Co-ordinating Committee who had favoured the proposal.

Fungicides.—The Board approved the resolution referred to and directed that agency houses should be supplied with a list of fungicides approved to date.

6. **Low-Country Sub-Station**

The minutes of the Low-Country Sub-Station Committee held on the 3rd March, 1958, had been circulated to members.

The Minutes were approved.

7. **Minutes of the Meetings of the Appointments Committee held on 29th January, 1958, 14th February, 1958 and 3rd March, 1958**

Pathologist.—The Board confirmed the appointment of Dr. D. Mulder as Pathologist on the terms recommended by the Appointments Committee.

8. **Minutes of the Standing Committee Meeting held on 14th February, 1958**

The Minutes of the Standing Committee meeting were approved.

9. **Report of the Co-ordinating Sub-Committee**

The Board gave detailed consideration to the Report of the Co-ordinating Sub-Committee, which was approved.

Mr. R. C. Scott congratulated the members of the Committee for their comprehensive and informative report.

10. **Staff**

(i) Acting Directorship.

Reported that Dr. A. W. R. Joachim, O.B.E., had accepted the Board's invitation to assume duties as Acting Director and had taken over from Mr. Tolhurst on 6th March. Dr. Joachim had conveyed his thanks to the Board for the confidence placed in him.

(ii) Research Assistant in the Chemistry Department.

Reported that Mr. M. Selvaratnam had assumed duties on 15th February, 1958.

11. **Any Other Business**

T. R. I. Ordinance.

The Board noted that the Cabinet had approved the amendment of the Tea, Rubber and Coconut Research Ordinances as follows:—

> "It was agreed that the Tea, Rubber and Coconut Research Ordinances should be amended to authorise the acquisition of lands under the Land Acquisition Act for the purpose of the Tea, Rubber and Coconut Research Boards and that the Bill should be given retrospective effect to cover any acquisitions already made."

The meeting terminated at 2-30 p.m. with a vote of thanks to the Chair.

Sgd. G. A. D. KEHL,
Secretary.

MINUTES OF THE MEETING OF THE BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON HELD AT THE OFFICES OF THE PLANTERS' ASSOCIATION OF CEYLON, COLOMBO, AT 2-00 P.M., ON FRIDAY, 27TH JUNE, 1958.

Present.—Mr. F. Amarasuriya (Chairman), Dr. M. F. Chandraratna, M.B.E. (Director of Agriculture), Messrs. B. Mahadeva (Tea Controller), H. Creighton (Chairman, Planters' Association of Ceylon), C. Selwyn Samaraweera (Chairman, Low-country Products Association of Ceylon), R. C. Scott, C.B.E., W. H. W. Coultas, N. M. Sanders, G. K. Newton, R. J. Gilmour, R. D. Wedd, J. L. D. Peiris, Errol Jayawickreme, V. G. W. Ratnayaka, M.B.E., Dr. A. W. R. Joachim, O.B.E. (Acting Director) and Mr. G. A. D. Kehl (Secretary).

Messrs. R. M. Macintyre and H. E. Peries, O.B.E. had intimated their inability to be present.

1. The Notice convening the meeting was read.

The Chairman welcomed Messrs. C. Selwyn Samaraweera and H. Creighton.

2. Minutes of the Meetings of the Board held on 7th March and on 2nd April, 1958

The Minutes of the meetings held on 7th March, 1958, and on April 2nd, 1958, were confirmed.

3. Matters Arising out of the Minutes

The Minutes of the meeting held on 7th March, 1958.

PAGE 3. ITEM 4(ii)—BIOCHEMISTRY

The Chairman reported that, as requested at the last Board meeting, the Acting Director and the Technologist had discussions with officials of the Ministry of Commerce and Trade, the Ceylon Institute of Scientific and Industrial Research, and the Ceylon Tea Propaganda Board on the subject of 'instant' or 'soluble' tea and had issued a comprehensive report to members.

The Board approved a sum of Rs. 25,000/- so that the investigation could be undertaken by the Ceylon Institute of Scientific and Industrial Research in collaboration with the Institute.

The Acting Director in this connection informed the Board that if any patent was obtained for any process or item of work, this would be in the name of the Tea Research Institute of Ceylon.

PAGE 3. ITEM 4(viii)—PLANT PHYSIOLOGY

The minutes of the meeting of the Committee appointed by the Board had been issued to members of the Board, and the great majority of members had replied that they were in favour of the new policy of selling planting material when the proposed new tea replanting subsidy scheme was implemented. The Board approved the sale of clonal material at 10 cents per shoot.

In reply to Mr. Wedd, the Acting Director said that a pamphlet on problems connected with the Tea Rehabilitation was being prepared and would be issued shortly.

PAGE 5. ITEM 10. REPORT OF THE CO-ORDINATING SUB-COMMITTEE

It was reported that both the Planters' Association of Ceylon and the Low-country Products Association had approved the additional cess recommended in the report. Mr. Gilmour, however, pointed out that the Ceylon Association in London had not yet given their approval and he thought that, in any event, the application to Government for the additional cess should be deferred until the appointment of a new Director who was to implement the recommendations of the report. The Board agreed.

The Acting Director was, however, given authority to utilise the surplus money from the Institute's funds to meet expenditure on bungalows, etc., for officers already recruited to the staff.

4. Minutes of the Appointments Committee Meetings held on 13th and 29th March and 21st June, 1958

(i) Entomologist.

The Chairman reported that Dr. P. Becker's papers were circulated to members, and 16 members had approved the appointment of Dr. Becker as Entomologist.

(ii) Chief Administrative Officer.

The Chairman informed members that Mr. H. J. Balmond was the outstanding candidate and it was the unanimous decision of the Appointments Committee to recommend him to the Board for appointment.

The Minutes of the meetings held on 13th and 29th March, and 21st June, 1958, were approved.

5. Minutes of the Standing Committee Meeting held on 9th May, 1958

Page 1. Committees of the Board.

(i) ADMINISTRATIVE COMMITTEE

In addition to the Chairman of the Board, the Director of the Institute and the Tea Controller, it was agreed that five other members, instead of the four recommended, should be on the Committee. The following were nominated:—

Mr. R. M. Macintyre
Mr. C. Selwyn Samaraweera
Mr. R. J. Gilmour
Mr. W. H. W. Coultas
Mr. J. L. D. Peiris

Mr. R. D. Wedd was nominated to act for Mr. R. M. Macintyre during his absence on leave.

(ii) *Experimental and Estate Committee*

It was agreed that only a representative from the Agency Section need be added to the present Committee. The Chairman of the Agency Section was accordingly nominated.

Page 2. Item 5. Staff. (i) Passages & Leave Terms—Overseas Staff.

After discussion the passage and leave terms recommended by the Standing Committee were approved in general, but it was left to the discretion of the Board, on the Director's recommendation, to decide in each particular case which leave period he should be granted.

Page 2. Item 5.(ii) Salary Scales for Ceylonese Staff.

As directed by the Standing Committee, the Acting Director reported that action had been taken to obtain comparative data for pension schemes from Insurance Companies and that the information so obtained would be referred to the Administrative Committee for a further report to the Board.

Page 2. Salary terms—Overseas Recruited Staff.

Since the Board had recently accepted the principle of recruiting senior staff from overseas on an all-inclusive salary, it was agreed, on the recommendation of the Acting Director, that appropriate action should be taken to consolidate the present salaries and allowances of old entrants as and when their contracts were renewed.

Page 3. Item 5(iii) Foreign aid and services of an expert in Nematology.

The Board approved the Acting Director's action in making an application to Government for the services of a Specialist in Nematology for a period of two years.

The Minutes of the Standing Committee were approved.

6. Minutes of the Building Committee Meeting held on 9th May, 1958

The Minutes of the Building Committee were approved.

7. Minutes of the Experimental and Estate Committee Meeting held on 10th May, 1958

The minutes of the Experimental and Estate Committee were approved.

8. Minutes of the Low-Country Sub-Station Committee Meeting held on 13th June, 1958

Page 2. Item 4. Valuation Report on Mutwagalla Estate

On the proposal of Mr. J. L. D. Peiris, seconded by Mr. B. Mahadeva, the Committee's recommendation that an offer be made for Mutwagalla Estate was unanimously approved.

Page 3. Item 6(i) Pembroke Bungalow.

The Acting Director was authorised to open negotiations for the sale of Pembroke bungalow to the Department of Agriculture.

The Minutes of the Low-country Committee meeting were approved.

9. Staff

(i) Post of Director.

The Chairman reported that Dr. Mellanby had regretfully declined to accept the post of Director.

10. Finance

Audited Accounts and Auditors' Reports thereon.

The Chairman reported that the Finance Committee had considered the audited accounts that morning and had recommended that the reports of the following accounts be accepted:—

1. T.R.I. Small Holdings Advisory Service.
2. St. Coombs Estate.
3. Tea Research Institute.
4. T.R.I. Junior Staff Provident Fund.
5. T.R.I. Junior Staff Medical Fund.

The audited accounts and auditors' reports thereon were accepted.

11. Any Other Business

Visit of Mission to study the Soviet Tea Industry.

A letter from the Tea Controller on the above subject was read.

The Board considered that it would be very useful for a Delegation from Ceylon to visit the Soviet Union to study the tea industry in the People's Republic of Georgia, which was stated to be one of the most highly advanced and productive tea industries in the world. It was agreed that the visit should be a short one of about two weeks duration and that the delegation should consist of not more than 6 persons, two of whom were to be officers of the Institute.

The meeting terminated with a vote of thanks to the Chair at 6-10 p.m.

Sgd. G. A. D. KEHL,
Secretary.

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